

November 18, 1957 75 Cents

AVIATION WEEK

A MCGRAW-HILL
PUBLICATION

Exclusive Report
On Countermeasures

•

How Blue Angels
Fly Air Shows

Navy's Blue Angels





THE CONVAIR JET 880 WILL OFFER YOU COMPLETE LUXURY—

Two on the Aisle!

Luxurious in every detail, the Convair Jet 880 will offer travelers in the new jet age first-class two-abreast seating throughout! In addition to unequaled luxury, the 880, with a cruising speed of 615 miles per hour, will be the world's fastest jet passenger plane!

CONVAIR

A DIVISION OF GENERAL DYNAMICS CORPORATION



SYMBOL OF SUPERIORITY



Driver views fastener at working height. Fastener is always in line of vision (Hi-Torque).



Hi-Torque Fastener gives positive torque thrust in driving or removal (Hi-Torque).

Undercut heads of driver heads, don't jam out (Hi-Torque).



Shallow recess does not affect head strength in critical workpiece (Hi-Torque).



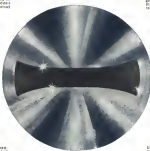
Patented Hi-Torque design. Minimum torque required, with and without Hi-Torque (Hi-Torque).



Full backing is applied after the driver has disengaged and is not in line (Hi-Torque).



Hi-Torque design, giving maximum torque with minimum backing (Hi-Torque).



Undercut recess does not affect head strength in critical workpiece (Hi-Torque).



HI-TORQUE FASTENERS

The key to Hi-Torque superiority is in the distinctive shape of the recess. It has an arcuate base; diverges outwardly from center; is undercut at sides. This shape ensures full backing thrust; locks driver in recess; gives greater torque values than heretofore possible.

Available in all metals including: alloy steels, 316 stainless steel, 17-4 PH, and 17-7 PH, AM 355, A-285, Inconel X, Greek Anodized, 4-4 and 4-4 Titanium, Vanoloy 1000, Thermoid J, and Rayon 920.



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JOHNSBURGH, PENNSYLVANIA

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INC.

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for measurement and control of

- TEMPERATURE
-400°F to +2000°F
- PRESSURE
0-5 to 0-8000 psi

to meet strictest requirements of

- TELEMETRY
- MISSILE RESEARCH
- AIRCRAFT CONTROL

an example of

TRANS-SONICS ADVANCED INSTRUMENTATION

OPEN TEMPERATURE PICKUPS

The illustrated OPEN TEMPERATURE PICKUPS are precision platinum resistance thermometers capable of high-temperature measurement of gases and non-corrosive fluids. Resistance increases, reported on remote-mounted pickup or on end, in direct contact with environment to be measured, and can have time constants as fast as 50 milliseconds. Polyethylene coatings of 50 mils can be delivered directly to customer's specifications. Units operate over selected ranges from -320°F to +2500°F (-200°C to +1378°C) with accuracy better than ±1% of full scale and repeatability of ±0.2%. Calibration Certificate giving precise 5-point calibration supplied with each unit. Stainless steel case and rugged construction withstand 200 psi pressure, a 25 g vibration, and 40 g shocks over 500-1000 Hz. Send for Technical Bulletin 1262 and 1266.

TRANS-SONICS
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Burlington, Massachusetts

AVIATION CALENDAR

(Continued from page 4)

- Working, Hotel Statler, New York
- Dec. 14—Aerospace Factors in Defense Engineering Institute of Radio Engineers & Aeronautics Society of America, Plaza Sheraton Hotel, Philadelphia, Pa.
- Dec. 14-15—Symposium on high temperature alloys, American Institute of Aeronautics and Astronautics, Naval Air Station Center, Philadelphia 12, Pa.
- Dec. 16-17-1967 Eastern Joint Computer Conference and Exhibit, Sheraton Hotel, Washington, D. C.
- Dec. 16-18—Air Traffic Control Symposium, The Vision and Methods of the Airway Modernization Board, sponsored by Traffic Institute, Philadelphia, Pa.
- Dec. 18—Can-Tech Development speaker, New York & B. Spang, USN, at Development & Material Center, at Fairport Club, Philadelphia, Pa.
- Jan. 8-8—Florida National Symposium Electronics Reliability and Quality Control, Hotel Statler, Washington, D. C.
- Jan. 14-15—Foster Instrument Fair & Symposium, sponsored by Instrument Society of America (Society of Instrumentation Engineers and Analytical Chemists), Sheraton Hotel, Philadelphia, Pa.
- Jan. 20-Feb. 3—Custom Institute for Commercial Control and Business Policy, Use of Southern California, Los Angeles
- Jan. 21-26—International Air Show & Exposition, Miami Field, Miami, Fla.
- Jan. 29-31—Fourth Annual Meeting, American Astronautical Society, N. Y. C.
- Jan. 19-20—Aerospace Society for Engineering Education, 1956 College Industry Conference, University of Michigan, Ann Arbor, Mich.
- Jan. 30-31—Seventh Annual Instrument Show, sponsored by Southern California Ventr. Association and Los Angeles Harbor College, at Los Angeles Harbor College, Washington, Calif.
- Feb. 4-6—Electronics Conference, Society of Plastics Engineers, Edgewater Beach Hotel, Chicago, Ill.
- Feb. 19—Air Force Society, Part in Phase 1, Dr. Hugh Wain, Music and Chorus, Southern California, CSE, Exposition Club, 1317 Spruce St., Philadelphia, Pa.
- Mar. 18-19—Second National Conference on Aviation Education, Hotel Mayfair, Washington, D. C.
- Mar. 17-18—Joint System Conference, American Rocket Society, American Society of Mechanical Engineers, Station-Hilton Hotel, Dallas, Tex.
- Mar. 17-18-1968 Nuclear Congress, sponsored by American Nuclear Chemical Engineers, 25 W. 45 St., N. Y. C.
- Mar. 24-26—Fourth International Instrument Show, Customs Hall, Westminster London
- Apr. 17-18—RTCA/NAS Research (A-44) War in Tokyo, Canada Center, C & Shoring, Chertsey, 145 South Drive, Toronto, Ont.
- Apr. 17-18—Institute of Environmental Engineers, Second Annual Technical Meeting, New York Hotel, New York
- Apr. 22-24-1968 Electronic Components Conference theme "Reliable Application of Computer Parts"

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*The only desk-side electronic computer
with direct programming and automatic
positioning of decimal point*

These exclusive features are just two of the many time- and money-saving advantages of the new IBM 610 Auto-Point Computer—a compact, low-cost, general-purpose electronic computer with many logical and arithmetic facilities to make engineering tasks more completely creative.

For example, the IBM 610 features single-instruction square root, sine/cosine division and multiplication, highly flexible tape units, and requires only a minimum of instruction to learn to operate the machine. The 610 has been designed with reliability as a prime consideration—built-in self-checking provides assurance of accurate results.

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A few applications
of the 610
Auto-Point Computer

- Flight Analysis
- Performance Evaluations
- Stress and Strain Calculations
- Data Reduction

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After 30,000 hours and 2,000,000 miles,
here's what PETROLEUM HELICOPTERS says
about Franklin engines:

Mr. S. S. Tisdal, our superintendent of maintenance, says he considers the Franklin one of the oldest and most reliable ever made.

Stan Gies, chief pilot of Petroleum Helicopters, has over 2,000 pilot hours in Bell helicopters. He says it proved to Franklin that they are in one of the most dependable engines he has encountered in his experience.

Our type of helicopter really gives an engine a workout, and it is a sure guarantee that a Franklin doesn't go the full 500 hours for a major overhaul.

The above are excerpts from a letter from Stan Gies of Petroleum Helicopters, Inc.



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UTAH



At its new Utah Division, on 11,000-acre, company owned facility, Thiokol is capable of producing solid propellant rocket motors of unprecedented size and power—engines that may hold the key to our country's operational ICBM and ICBM missiles.

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how to defend
a 13-ton aircraft with a 3-oz. motor

Westinghouse gyro motor furnishes precise, dependable signal
for super-accurate fire control systems

Westinghouse Gyro Motor Division, 10000 130th Street, Grand Rapids, MI 49508. For more information, call 800-541-3333 or 616-961-1000.

Multi-ton sky giants, decisively armed by a 3-ounce motor. That's precision! — and it's made possible by the Westinghouse Gyro Motor.

This "mighty-mite" spin motor is the heart of many super-sensitive aircraft gyroscopes. It's assembled to a temperature- and humidity-controlled routine—dynamically balanced—thoroughly tested—and shipped as a hermetically sealed precision bag and end envelope.

This accurate case, plus 40 years of Westinghouse aircraft electrical experience, insures a minimum of 1200 hours maintenance-free service from every motor.

If you would like additional information on the full line of

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All inquiries and information are kept in strictest confidence, to safeguard both your commercial interests and national security.

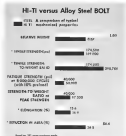
YOU CAN BE SURE...if it's Westinghouse

AIRCRAFT EQUIPMENT DEPARTMENT, LIMA, OHIO



SPS Hi-Ti titanium aircraft bolts are regularly manufactured in four standard configurations: internal wrenching tension bolts, 12-point external wrenching tension bolts, hexagon head external wrenching shear bolts, and flush head external wrenching shear bolts. Weighing 43% less than steel bolts of equivalent dimensions, they can save you as much as 1500 lb. per airframe—while no loss in strength.

SPS Hi-Ti titanium bolts help you build lighter airframes without sacrificing strength



Hi-Ti vs. alloy steel. Tensile, elongation and reduction area properties are based on the performance of bolts from SPS's own endurance tests, as determined by subjecting bolts to constant load alternating between maximum and 10% preload for a total of 2,000,000 cycles without inducing failure. Significant improvements in life is implied in weight ratio of endurance time.

SPS Hi-Ti titanium bolts help you solve the problem of reducing airframe weight without compromising strength. They weigh 43% less than alloy steel bolts of the same size. One lb. of them can do the work of 1.5 lb. of steel bolts. Yet in tensile-strength-to-weight ratio and fatigue resistance, they outperform steel.

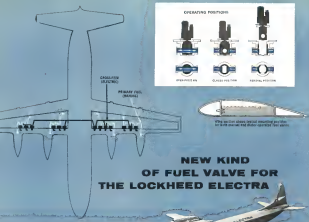
Once considered a laboratory curiosity, titanium bolts have for some time been standard production items at SPS. Hi-Ti bolts are found in many advanced design operational aircraft. This is because SPS—producer of the first successful titanium aircraft bolt—invested over \$300,000 and several years of high priority research in learning how to deal with this promising but sensitive metal. Today SPS has the most extensive facilities in the industry for the production and testing of titanium fasteners. As a result, we can give you both the technical assistance and the delivery you need to utilize fully the advantages of titanium bolts in your current airframe projects.

For more information on Hi-Ti titanium aircraft bolts, write Aircraft Products Division, STANDARD PUMPS STEEL CO., Jenkintown, Pa.

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SPS
LIMONING INDUSTRIES



The section shows detail mounting position for both manual and electric operation. See specs.

NEW KIND OF FUEL VALVE FOR THE LOCKHEED ELECTRA



Lockheed issued this challenge: the wing configuration of "Electra" called for an entirely new concept in inerteless fuel control valves. In open competition with other valve manufacturers, General Controls met this challenge head-on and was selected because of its volume production reputation and design ingenuity. The selected General Controls design best met Lockheed's requirements—an operating characteristic, unique accessibility for simplified maintenance and dependable performance under all operating conditions.

Now all fuel lines are routed through the integral wing tanks, saving valuable space for vital engine controls. The valve assembly can be removed for service without disconnecting fuel lines or draining tanks.

It is this ingenuity that causes important aircraft manufacturers like Lockheed to rely on General Controls for automatic and manual valves. If automatic controls figure in your specifications, contact—result—General Controls.

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General Controls Co., 801 Allen Avenue, Glendale 1, California



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In the beginning... it was Sidewinder and Avion, under the direction of the Naval Ordnance Test Station, developed the first successful **INFRARED** guidance system for this vital weapon.

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CINCINNATI **Hydroform** MACHINES

ALUMINUM



2 Draws

2 Draws

2 Draws

2 Draws

1 1/2 Draws

STEEL



1 Draw

1 Draw

2 Draws

2 Draws

1 Draw

of parts of almost any shape

BRASS



2 Draws

1 Draw

1 Draw

1 Draw

2 Draws

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STAINLESS



2 Draws

2 Draws

1 Draw

1 Draw

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ROTODYNAMIC

by **STRATOPOWER**

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IT'S NEW ... IT'S TOMORROW

Tomorrow's demands an advanced hydraulic line for higher reliability at higher temperatures and higher speeds. It's no secret that today's pumps fall short serving these more exacting demands. ROTODYNAMIC, a newly patented hydraulic principle, actually improves its mechanical performance in these areas.

If your requirements are for high speed hydraulics with a DIRECT DRIVE range between 3000 and 4500 rpm, you are looking ROTODYNAMIC. The STRATOPOWER ROTODYNAMIC Hydraulic Pump is designed for operation on all types of fluids (even the heaviest viscosity oils) delivering 10 to 30 gpm at 2000 psi.

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Getting there is a luxury in only half the story behind the success of America's "Royal Coachman." Further facts—this DC-7 airmail flight offers true luxury features at auroch firm—may be secured upon ticket purchase and on economical mail bought for auroch shift. There's even a passenger lounge for relaxation.

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Tight now, at Rollway, new high-temperature steels are being tested for generation into ever higher speeds and temperatures. Experienced engineers and designers under their skill with Rollway's quality control personnel to maintain exacting standards— from laboratory experimentation to rapid pre-qualification testing.

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Scotch optics Cambridge developed light gun used at the VOLSCAN air traffic control system. One of the gun puts an accurate "light" under control of a computer which directs the aircraft in a preset landing route into waiting airplanes.

By Air Force Photo

CAMBRIDGE RESEARCH CENTER DEVELOPS SUPERHUMAN EYES AND EARS FOR AIR FORCE

At the Air Force Cambridge Research Center, in Bedford, Mass., the Air Research and Development Command has a broad program under way in electronics, geophysics and human engineering—and is expanding into many new areas in these fields.

The objective of much of the Center's electronics research is to improve the systems and instruments that serve as visual and auditory senses for the Air Force, making it possible to control and detect the invisibly fast activities and phases of today and of tomorrow. Such work has included development of "super systems," such as the SACRE air defense system, which provides coordinated, aerial detection and reconnaissance over a vast area. Other projects include radar, tactical air control systems (TACS), advanced radar for ground, aircraft and missile systems, automatic aerial traffic control systems, such as VOLSCAN, research in computer techniques, as well as existing computers for Cambridge's own use, and extensive work in communications, data processing, computers, radiohams

and weapons control systems, and many other fields. Cambridge is cooperating closely in the International Geophysical Year—as well as doing its own research into meteorology, natural physics, stars, detection and weather forecasting techniques, the upper atmosphere, nuclear physics, jet stream research, and many other areas now becoming of intense interest to practical science.

This Center is also responsible for a broad program in "human engineering." It is concerned with research on hearing, speech intelligibility, and information processing by the human operator. Other studies involve the human limitations and capabilities of members of complex communication and control systems.

Cambridge, headed by L. G. Harrison Field, makes use of the talents of hundreds of government scientists and engineers—and also draws upon the brain power of a great army contractor and colleges, as well as military organizations—helping to keep the United States technically second to none.



This is one of a series of ads on the included activities of the Department of Defense.

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Engineer at Ford Instrument checks airborne data transmission tape printed developed for Air Force built control system.

ENGINEERS of varied abilities are field a future in 1960 EQUIPMENT OF Motor for Information.

November 18, 1957

AVIATION WEEK

Vol. 47, No. 30

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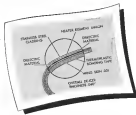
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EDITORIAL

Mr. McElroy Goes to Bat

During his first months in the Pentagon as Secretary of Defense Mr. Neil McElroy, the Cincinnati soap magnate, has made a vigorous start on reversing the most dangerous policies of his predecessor, the Detroit automobile engineer Mr. Charles E. Wilson. Last August (AVR Aug. 19, p. 21) we warned that Mr. McElroy was exhibiting a "can of worms" in the Pentagon out of his own making that would make it extremely difficult for him to make the proper progress before he outgrew this name.

In his first few months in office Mr. McElroy has made his position crystal clear as far as basic issues that reverse prior Pentagon policy.

These are:

- **Quick affirmation** of his belief in basic research as a foundation for satellite technology. This was one of the major issues in the Pentagon during Mr. Wilson's regime. He never lost an opportunity to voice loud denials of basic research and the impractical "upgrades" who wanted to find out why the guns at Paris, or to build an atomic powered airplane or explore space.

Right Side

The fact that Mr. McElroy put himself quickly and unequivocally on the record on the right side of this vital issue should do much to heal the breach between the scientific community and the Pentagon opened by Mr. Wilson's open contempt for basic research.

- **Quick restoration** of the \$150 million cut in research and development funds below the level appropriated by Congress. This cut was one of Mr. Wilson's last official acts in the Pentagon and its restoration was one of Mr. McElroy's first decisions as his successor. It vindicated Mr. McElroy's early affirmation of his understanding of the role of science in military technology.
- **Prompt action** to restore \$400 million in government funds being withheld by the Defense Department in no effort to keep under the \$35 billion expenditure ceiling imposed by the White House for Fiscal 1958. The tremendous financial debilitation of the aircraft industry threatened by this action has been reported in detail during the past months by our military editor, Claude Winter. The fact that this action meant that the United States government would in effect be "withdrawing" on its legally contracted debts and would force a

treacherous slow down in the production of new military weapons was quickly grasped by Mr. McElroy. He was equally prompt in taking action to restore these funds and move toward a workable solution of the problem.

Industry's Own Funds

We predict that the aircraft industry will be more than willing to secure a larger flow of financial support for its operations in the climate created by Mr. McElroy's understanding of the issues at stake.

- **Decision** to permit the Army to make a satellite launching attempt with its Jupiter C three stage research missile. The basic decision to separate the satellite program from existing military technology and hardware spotlighted more than anything else the basic misconception of the role of science in military technology that had dominated government thinking in the past. Mr. McElroy's decision to permit the Army to use its all the shell hardware for a satellite program is a reversal of this foolish policy and a positive step in the right direction.

In view of this action it appears possible that Mr. McElroy will also ease the stigma placed on space research by his predecessor and soon lay the groundwork for a moral program in this area, steering carefully between the orthodox pioneers who want to establish colonies on Venus and the ultra conservatives who still can't see the military implications of satellite and manned space systems.

Burdensome Legacy

Mr. McElroy's task in reversing the Pentagon at one of the most critical moments in our history is a task in enormous complexity by the legacy left by his predecessor. He will have to wrestle with these problems as well as the new ones created by the galloping technology of our times.

Mr. McElroy is off to a good start with a series of steps that should help to his support all of the military, scientific and political elements that give the genuine interest of their country top priority and are willing to work vigorously and unselfishly to preserve its future.

—Robert Hotz



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 Charles E. Bassett, executive vice president and a director.

Ernest G. Reed, a director, Aerojet Motors Engineering Co., Van Nuys, Calif.
 William H. Gaudin, a director, DuPont City Company, Pasadena, Calif.
 Raymond W. Smith, president and chief executive, Technology Instrument Corp., Alhambra.

William L. Marlin, president, Los Angeles Aircraft Co., Pittsburgh, Pa.
 A. B. Dineen, vice president, Mr. White in contract, two years.

H. B. Bellamy, senior vice president, Progress Management Dept., General Electric Aircraft Co., Dallas, Tex.
 J. E. E. Brown, program management director and Project Manager, long-range planning director.

Leonard M. Clark, vice president and General P. Hopper, vice president, engineering, Sci-Tec Inc., Union City, Pa.
 Clifford C. Vashel, vice president, manufacturing, Shell Chemical Co., Manassas, Va.

James H. Smith, Jr., vice president and sales manager, Van Zee Associates Inc., Baltimore, Md.
 Pauline H. Catterway, a vice president, Allen B. Du Pont Laboratories, Inc., Clinton, N. J.

Harry T. Jiles, vice president, manufacturing, Logistics Aircraft Company, Inc., Torrance, Calif.
 Walter H. Powell, vice president, later retired, Aeroflex Co., Philadelphia, Pa.

Doris E. Arden, vice president, sales, Techno Inc., Springfield, Mass.
 F. J. Power, E. F. Miran and William M. Mulvaney, vice presidents, Air-Chemical Manufacturing Co., Milwaukee, Wis.

Dr. Walter E. Dunsberger, technical director, the president, Bell Aircraft Corp., Allentown, N. Y.

Honors and Elections

Adm. Arthur W. Radford (ADM) has been named to receive the 1947 Foxcroft Memorial Award by the National Aeronautics Administration. The award is given annually to "the distinguished American whose leadership has promoted significant contributions to aeronautics, aviation and progress in the interest of national security."

Changes

For Thacker, chief engineer, Thacker Co., Torrance, Calif.
 The project systems branch of Lockheed's Missile Systems Division, Sunnyvale, Calif., has appointed the following staff managers: F. E. Patten, electrical and construction; R. J. Wong, inspection system; Hans Winkler, logistics.

Charles N. Lundy, systems engineer, chief, Avco Inc., Windsor, N. Y.
 Dr. Edmund J. Sander, Jr., director of engineering, Aeroflex Laboratories, Inc., Los Angeles, Calif.

INDUSTRY OBSERVER

► Lockheed Division of North American Aviation is developing a rocket engine of under 10,000 lb thrust with a firing time of up to 15 sec for aircraft applications. Engine, being built under Navy contract, would give existing aircraft additional speed capability plus some maneuvering ability at higher than normal altitudes, in greater horizontal speed capability.

► Approximately nine Fairchild Goose missiles have been flown in development program to date. Except for structure surrounding tailfin engine, design is an almost all-plastic configuration about 90 in. long with 18-in. wings.

► The latter has spent approximately \$17 billion thus far in support of development programs for titanium and its alloys. Industry is now working closely with metal developers to achieve alloys best suited to unusual pressure conditions.

► Purolit Aircraft Co. is developing under Navy sponsorship a four-engine drone helicopter for over-the-horizon anti-submarine work using sonar, other gear. Machine is nondirectional due to square configuration, can carry depth charges.

► Lots of Lockheed F-104 equipped with M11 Cruise missile systems are scheduled to begin within the next future.

► General Motors Machine Co., in experiments to investigate metal cutting at extremely high speeds, has achieved metal removal on one type of steel at 35,000 surface ft per min. Studies are aimed at helping overcome production difficulties during next decade.

► First aircraft produced under North American Aviation's WS 201A long-range intercepter project will be designated the YF-105.

► Work on solid propellant powerplant for Navy's Polaris fleet ballistic missile has been curtailed by recent accidents at Aerojet's Sacramento plant propellant plant in which several key personnel were injured and facilities severely damaged by several explosions.

► Pratt & Whitney 737 jet transport is having a Pratt & Whitney 775 turbojet engine installed in the number two position (behind on the left wing for right). Nostrums, modifications are scheduled to be completed by the end of the month.

► Rehearsal testing is being continued at Naval Ordnance Test Station, China Lake, Calif., on Aerojet-General's solid propellant booster for Boeing B-57C intercepter missile.

► Army, in its drive to end helicopters operating rotary blades, says new important factor in the form of engineering changes. Army holds view of drive as made without proper consideration of the amount of vibration rendered obsolete by retrofit costs. Army policy now is to avoid retrofit with improved components unless there is good economic justification in order to limit drive on current expenditure rate.

► USAF's new standard function range is to be operated out of Mexico by Air Force Avionics Center, Elgin, Ill., eventually is expected to serve as test area for all major USAF missiles except intermediate range and intercontinental ballistic missiles. Ballistic missiles, including Navy's Polaris fleet ballistic missile, will demand all true and facilities of USAF Missile Test Center, Cape Canaveral, Patrick AFB, Fla. Phases of Boeing B-57C intercepter missile probably will move to Elgin, and range also will be used for some launch, control and gun testing.

► Lee Inc. is working on improved weapons guidance instrument system for USAF. Recent contract by Air Materiel Command for continuance of the work valued \$5.4 million.



Dr. Aron Wikstrom

A SCIENTIST-ENGINEER SPEAKS ABOUT AVCO

Most men agree it is being appreciated that no sharp border-line has between science and engineering should exist. These two fields must strongly overlap to bring into being the fullest creativity of both.

To span the gap between science and engineering is one of the big problems—it is one which no laboratory can ignore. In this no-man's-land these are engineers who are physicists and physicists who are engineers. Avco is strengthening a staff of such men, men who are highly trained in the sciences but who realize that the ultimate goal is to apply this knowledge in ways that will enable mankind to live better in a better world of tomorrow.

Industrial research must rest on the foundation provided by the creative basic scientist. Yet its end product—new commercial items, new defense systems and new techniques—comes into being only through the insight and skill of the creative engineer.

Avco's research division has a climate of creativity, coupled with long-range corporate goals. In this atmosphere creative and far-sighted professional men, whether scientist, engineer or any one of the infinite number of combinations thereof, will find rewarding work at the Research and Advanced Development Division of Avco.

Avco Research and Advanced Development Division

Dr. Aron Wikstrom
Special Technical Assistant to the President

Avco
Research & Advanced Development

Personnel shown are new Research and Development Center now under construction in Wilmington, Massachusetts. Scheduled for completion in early 1955, the advanced laboratory will house the national and local staffs of the Avco Research and Advanced Development Division.

Avco's new research division now offers unusual and exciting career opportunities for exceptionally qualified and forward-looking scientists and engineers in such fields as:

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Aeronautical • Applied Mechanics • Chemical • Electrical
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Write to Dr. R. H. Johnson, Scientific and Technical Relations,
Avco Research and Advanced Development Division,
30 South Dixie Street, Littleton, Massachusetts

Washington Roundup

Why New R & D Ruling

Discount reports that the Defense Department's new use and expansion of its "Palmer as Basic Research" would last week points the way to a 1955 increase in the research and development budget. More money will be spent in this area but a doubling of the program is not likely. Real reason for the new policy, directed to reduce badly damaged morale among scientific workers in the Defense Department universities, government laboratories and industry. Headquarters and new plans to support basic research was a pre-Sputnik idea. launched not long after Frank Newman had his major row with the Defense Science Board last spring (AW Nov. 17, p. 25). Department of Newborn, from the post as Assistant Secretary for Research and Engineering and of Charles E. Wilson as Secretary of Defense made it hard to achieve the new policy.

Non-Partisan Blame

The main protagonists of non-partisanship in the forthcoming Senate Preparedness Subcommittee's investigation of the missile-satellite programs are being accepted with tongue in cheek in congressional circles (AW Nov. 11, p. 31).

Latest condemnation now by Edwin L. Weir, newly appointed director of the subcommittee which is headed by Sen. Lyndon Johnson (D-Tex.), Senate majority leader. Weir, 68, covered New York corporation attorney, announced on taking over direction of the panel.

Sen. Johnson is not interested in fixing the blame. He is interested in finding out what is right, not who is right, and what is wrong, not who is wrong. He wants this study to be based on facts. He wants to know all the facts to make the country safer and wiser.

In public speeches and testimony, however, Democrats from the start of the week program lag with the resignation of the Eisenhower Administration in 1953, Republicans with the 1945 U. S. invasion.

Preparedness Subcommittee hearings are scheduled to start Nov. 23. The plan is to have some open and some closed door sessions.

Position Available

President Eisenhower's report that Secretary of State John Edgar Hoover will add a senior adviser to his staff will be offered with some confidence from the State Department now. The search has been on for a new and one of the top flight men who have been approached will accept the job. There are two reasons. One to which the State Department will admit is a budgetary. The other, not mentioned, is the search check to check an available candidate would be subjected. An scientist worth his salt can get just as good a job outside the government without losing the honor of a resident from the White House.

Haladay's Role?

One of the major mistakes resulting from President Eisenhower's "confidence-building" speech occurred in the staff of William M. Haladay, Special Assistant to the Secretary of Defense for General Motors. The White House and State have been ordered to make sure Haladay "is cleared with all the authorities that the Secretary himself possesses in this field."

When the job was created in March, 1953, Charles E.

Wilson, then Secretary of Defense, and Egan V. Maguire had been given authority to get the missile program "back on track." The directive establishing the office was: "Mr. Haladay is to be responsible for the direction and coordination of all activities in the Department of Defense connected with the research, development, engineering and production of guided missiles, except those types already adopted for service use."

When Haladay entered the picture last May, the job was expanded and the Vanguard missile program included in Haladay's portfolio. Wilson's opinion was that the title "is a scientific mission, but it's not of an great interest to the part of the military."

Eisenhower's remarks probably were made to torpedo the Wilson philosophy once and for all, giving Neil H. Aldrich, now Defense Secretary, full responsibility to work on scientific concerns.

Missile Expenditures

Defense Department expenditures for missile programs for the last fiscal year (1954) through 1955 will amount to over \$6.5 billion, according to Dr. Paul D. Foster, Assistant Secretary of Defense for Research and Engineering. The breakdown: 1955: \$738 million, 1956: \$1,165 million, 1957: \$2,142 million, 1958: \$2,414 million. The 1955 figure does not add to an acceleration which might be inferred for the program.

West Coast Requests

U. S. attempts toward getting additional notes for foreign air carriers in the West Coast appear to be making progress because of the large number of requests. Almost every foreign airline now has a contract to fly to the West Coast would like to extend its routes across the U. S. or be permitted to fly the Pacific Coast direct from Europe. State Department and Civil Aeronautics Board officials are making an effort to get the airlines to discuss civil aviation matters with various countries including Japan, Switzerland and France.

Progress Payment Cut

Cost-plus-fixed fee contractors no longer are eligible to benefit from government financing of all costs for major items, such as progress and services. New Defense Department Directive (No. 7000.6, Nov. 1, 1955) cuts this program payments to a maximum of 50% as provided in 1954, more than two years ago (AW Nov. 4, p. 20). Directive says specifically that the extent of the contractor's capital investment will be considered when the fee or profit is fixed. An exception can be made in the case of a small business where the rule would make a hardship.

MATS Investigations

Staff of a special Senate Committee Subcommittee headed by Sen. Warren Magnuson (D-Wash.) moved toward the study with an investigation of the operations of MATS, Air Transport Service, submitting a detailed questionnaire to Defense Department. Hearings are expected to begin after the convening of Congress in January.

—Washington staff



SOVIET T-3 intercontinental range ballistic missile, with its Red Square on highway transports during 40th anniversary celebration of Bolshevik revolution. T-3 has a range of about 10,000 miles and uses liquid oxygen and kerosene propellants. Design shows many bare influences of German V-2 technology including control system. Missile is about 70 ft. long and has been in production nearly a year.

Man in Space Needed to Recapture Lead

U. S. scientists warn that satellites are not enough to overtake Soviet's technical-propaganda lead.

By Evert Clark

Washington—Increasing number of scientists are warning that the U. S. will not regain technological preeminence until it puts a man into space first. The world risk, at least for years, by the most optimistic estimate.

Opponents of who won this important lap in the race for space, many scientists believe this country will live as the shadow of superior Soviet achievements in this field for the next several years.

U. S. but word, dropped at pace that it is not in competition with Russia in attempting a lap presently riding to the Vanguard satellite program. This has been warned for ballistic missile programs until now.

It also departed from policy by ordering Army to begin launching satellites with its Jupiter C ballistic test vehicle. Until now, the satellite program has been described as a purely scientific effort, deliberately kept apart from weapons programs.

But a growing number of scientific

and technical advisers, many of them within the government, believe the Russian military technological propaganda threat demands work holder programs than anything now being given across consideration at the government levels. Some even suggest stopping such steps in the legal development of space as the hypersonic bomber and trying to put a permanent space station into orbit within five to seven years.

Soviet Missiles

Russia already has missiles capable of carrying 5,000 lb. warheads—its most important offensive power—over ranges of 5,000 mi., according to some estimates. Launching of satellites and intercontinental missiles are considered essential means to confirm this.

Some of firing of intercontinental range ballistic missiles also leave little doubt that Russia is well on the way to solving re-entry and guidance problems for missiles at this stage.

If Soviet T-3 ICBMs (see box) also are used as later stages of the T-3 or intercontinental ballistic missile, as most

observers believe, then accuracy of the ICBMs launched in far more than the guidance solution for the ICBM also is not at hand.

Sputnik I and Sputnik II launches—using the R-7A vehicle, modified from the ICBM—showed the first steps in an extensive, carefully-planned Soviet space program. In addition to the 278,000 lb. thrust engine used in the ICBM and Sputnik launches, Russians now have an engine rated between 300,000 lb. and 1,000,000 lb. thrust for use in hypersonic bombers or for space exploration.

T-4 hypersonic bomber test vehicle and R-6 hypersonic bomber are scheduled for flights in the latter half of March 1958, already are at least in the planning stages.

Most U. S. observers do not believe either Sputnik launching gives so much reason of Russian missile guidance capability. They say error indicated if Russians were aiming for circles instead of elliptical orbits is so great that it is unsafe to assume it is an error. High accuracy of ICBM firing also casts doubt on the circular orbit theory.

Although chemical propellants are capable of having achieved the Sputnik satellite launches and probably will continue to be used for all U. S. satellites, rockets, space exploration will

require advances in this area as well as others.

Russians continue to boast of their apparent lead in rockets and space techniques but admit they have not solved all their problems either.

Academyman Leonid I. Sedov, writing in *Tech* on his trip to Moscow, is chief of the Soviet delegation to the International Astronautical Congress (IAW Oct. 14, p. 26) credited his country's lead to "much understanding of the correct technical paths and correct concentrations of effort and means on the most important tasks."

"The reports presented by foreign scientists point out, to conclude that is solving the problems of cosmic flight, the USSR has moved ahead not alone by the fact of launching an orbital earth satellite," Sedov said.

Soviet science also has about important achievements in the field of pure theoretical investigation."

Sedov said acceptance of Russian as an official language at the Congress was a significant demonstration of the esteem in which Soviet research is held.

Natural problems "left to be solved," he said, include return of satellites to the earth, launching of manned satellites and flight to or around the moon with return to the earth.

Moscow Radio also said last week that "at present it is not the aim" to recover satellites. The broadcaster stated that animals had been used for rocket flights even though "the rocket burned itself out," and said "something similar can be applied up to a Sputnik. The task for the moment is to get them completed, but reusable."

Sputnik II's radio transmitter died several days after launching, leading

Soviet Missiles

Washington—Soviet missile and hypersonic bomber program indicates that missiles are in production, testing or development stages.

• T-1 (M-100)—Motor of 77,000 lb. thrust, inspired from the German V-2 engine. Present and test vehicle for intercontinental range ballistic missile (ICBM).

• T-2 (M-100)—ICBM with 228,000 lb. thrust motor. Motor has been tested in only in 1958 or 1959.

• T-3 (M-100)—Intercontinental ballistic missile (ICBM), probably using two 228,000 lb. T-2 motor plus a T-1.

• T-4—Sputnik launcher, modified from the ICBM.

• T-5—Hypersonic bomber test vehicle.

• T-6 (M-100)—Hypersonic bomber with capability of Mach 12.5. Rocket engine of 800,000 to 1,000,000 lb. of thrust for this vehicle and for space research use in development now.



USAF THOR intercontinental range ballistic missile is roughly the same length as the Soviet T-1 on the opposite page. Now one shape set actually different. Russians had extremely pointed nose on their missile models while Thor latest nose cone is good example of U. S. re-entry technology. Thor was guided by rocket for control while ICB uses cones to deflect most re-entry in V-2 fashion.

strength to Russian statements that the experiment was intended to test only that long, and that the dog was dead.

Sputnik is transmitter failed three weeks.

Possible last week, confirmed that Sputnik II is the first stage of a newly stage rocket (IAW Nov. 11, p. 28) and said it used a small propellant nose cone when it went into its orbit. Ground stations said and X-15 rocket were launched with instruments mounted on a capsule while further tests. Behind this was a spherical container similar to the first satellite. It contained two transmission, electric batteries, a heat regulator and sensing devices to measure temperature, etc.

Back of this was a hermetically sealed sphere protruding from the satellite's body and containing Lark, her food supply and instruments for recording her respiration, heartbeat and blood pressure.

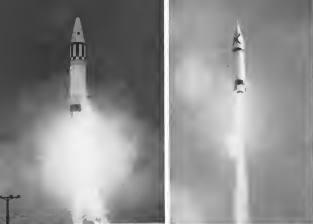
Autumnier E. Y. Zigel wrote in the *Aviation Week* paper that hundreds of satellite materials will go to 3,000

mi. and most giant satellites called "cosmic satellites" and carrying not only scientific instruments but fuel for atmospheric steps.

U. S. efforts to regain lost prestige, confidence from Sputnik II, in assignment of DX priority strings to construction and development, production and construction materials for Project Vanguard Vanguard has been designated as Break Ball. US on Defense Department's Mission Urgency List.

Army's satellite launching schedule had not been announced late last week. But observers who have followed the Army program have found that sending larger than 500 lb. can be launched before the end of 1958 by Army or Navy—leaving the U. S. approximately a year behind Russia's present position.

The five U. S. satellite missile programs, meanwhile, are averaging a 4.44 hour week. The average is rated considerably by testing programs, which are the most active. Average shortly be for Defense Secretary Neil McElroy, took office Nov. 10 hours.



UNUSUALLY close, detailed photographs show branchings of Soviet intermediate range ballistic missiles at Cape Canaveral launching site.

Killian Advocates Basic R&D Changes

By Claude Wate

Washington—Dr. James Rhyne Killian, Jr., now Special Assistant to the President for Science and Technology, believes the U. S. must make two basic changes in its approach to research and development.

• It must strengthen coordination of scientific activities at the policymaking level. More skill in coordination and planning at the top, Killian contends, will improve the effectiveness of the research and development effort. "All down the line," Congress should be aware that scientists and engineers are essential to policy making.

• It must accept new views of budgeting for research and development. The necessary compromise between economy and requirements must include allowances for "maximum freedom, a willingness to fail and a long view."

Sputnik Benefit

Dr. Killian's approach to the recent developments are outlined now to Washington observers of U. S. effort ever the

past few years to keep Soviet Russia from surpassing the country in the field of technological achievement.

Some critics feel that one of the greatest benefits of the Russian satellite achievement will be that the long-standing advice of the president of the Massachusetts Institute of Technology will probably be adopted.

Dr. Killian has given this advice before many tribunals in the House Committee on Government Operations, where he testified at length in 1954 before a Subcommittee on Military Operations headed by Rep. R. Walter Reuther (D. N. Y.). It was expanded last year for the companion subcommittee of the Senate headed by former USAF Secretary Stuart Symington (D. Mo.).

In addition, there was a "Killian Report" on the status of our scientific effort that serves as a classified document. This study actually was made for the White House by a subcommittee of the President's Scientific Advisory Committee of which Dr. Killian was a member.

It is significant that the results were

sent before the President himself and then sent to the National Security Council. They were dutifully read at the same time commensurate, concluding that the Russians might take the technological lead over from the U. S. in the period 1960-1965. They reported that progress in guided missile development, atomic production of long range bombers and jet fighters and other advances.

Turkish Radar Reports

The report was made in early 1955, and, at that time, Dr. Killian had the advantage of early sightings of Red satellite jets from the two brand new radar observation post near Samsun, Turkey, which was disclosed by AVIATION WEEK on Oct. 23 to 360 ft. feet, it is believed that the Killian study and the establishment of the radar post both resulted from intelligence reports on Red satellite activity going back to 1951.

Newspaper accounts of what was in the Killian report, emphasizing the possibility, that Russian satellites soon would

be a threat to the U. S., was itself closed at the time by the White House. The spokesman who said the press reports were inaccurate was Alvin Saveler, then acting press secretary to the President and now Assistant Secretary of Defense for Public Affairs.

Killian Testimony

Dr. Killian told the Scovington Committee last year that he had no ac-
countability for seeing to it that the recommendations of the Killian report were carried out. "The 1954 study, he said, was made by a group of consultants 'who made a report and then withdrew.'"

However, he should not assume responsibility for the job to do then he gave to some capable men. Before the Buchanan Committee two years earlier he declared there was an analogy between private industry and the government in this area.

A program manager, he said, would be a vice president in charge of research and development to participate directly in administrative decisions. He added:

"We are approaching the limit of operational coupling in the National Defense Department. We should develop it further and we also should apply it in each of the three military services."

At the time he spoke, the office of an Assistant Secretary of Defense for Research and Development was 90 weeks old. The post was filled by Donald Quarles, now Deputy Secretary of Defense. The Air Force is the only branch of the military with an Assistant Secretary for R. & D.

Importance of Management

It was before the Buchanan Committee that Dr. Killian put such emphasis on the importance of management. He found evidence that the top military leaders were poorly informed about technological developments and there was poor use of scientific counseling in the formulation of military plans. He said Quarles should have a close relationship with the Joint Chiefs of Staff and that its military houses were guilty of not wanting this counsel. Dr. Killian told the committee on June 17, 1954.

At the present time, important new technological advances, in jet, missile, air piling up and are only partially used because our normal planning and decision-making processes cannot respond and make use of them as fast as they become available.

"We need more of what the engineers and scientists thinking about many of these problems that can be tied together to form a whole greater than the sum of its parts."

Dr. Killian was speaking last time



T-2 IRBM shown on transporter with interstage pins being stored launching and aiming area armed with sub-orbital guns. Note pointed nose.



REAR VIEW of T-2 IRBM shows large diameter nose and control vanes submerged in rocket exhaust. This appears to be fixed for stability rather than movable for control.



SHORT RANGE liquid fueled missile shown on mobile field launcher has range of about 200 mi. This missile has been in production for several years and is in field use.

project is the new Department of Science and Technology. The information and progress.

Control during home for scientific information within the new department. This would include a large staff of qualified persons to assemble, analyze, transfer and disseminate scientific

information through various channels. The use of this type of service for research has been established," the administrative staff concluded.

Establishment of an Academy of Sciences patterned after the Russian science academies, with nominations by the Academy of Recommendations of an ap-



CLOSE-UP of short range solid propellant rocket on mobile field launcher.



PANORAMA of Soviet warheads moving through Red Square, (above) with ground-to-air missile in land on mobile field launchers followed by Kremlin solid propellant longer rocket between mounted on truck and Russian Jumbo type short range missile in rear. Closeup of Soviet ground-to-air missile on mobile field launcher (below) shows two stage solid propellant rocket with large fuel line for mobility and smaller movable nozzles for control. First mobile launcher for guidance are loaded on more. Launchers very compacted on power source for driving needed to fire position.



pointing board of leading scientific researchers.

On the international level, Sen Hien Jackson (D-Wash.) last week presented to the North Atlantic Treaty Organization a plan for NATO to sponsor scientific education (AW Oct. 26, p. 28). This would include cooperative training and research projects including a global missile training center in Europe, a NATO-wide program for missile training, and a NATO-funded missile program for scientific research and studies. The program would be administered by an Atlantic Community Foundation composed of two representatives of each NATO nation.

While the way to build the state's technical manpower reserve continued to grow momentum in Congress, Sen John Stennis (R-Miss) continued against a youth training program that would emphasize the outpouring of quantities at the expense of quality. Admitting lack of money is a factor in the difficulties, Stennis said, the major cause has been the steady deterioration of educational standards.

Wilson Says Sputnik Concern Unrealistic

Detroit—Charles E. Wilson, who left the Pentagon after a month ago put in time to avoid the claim that he, Russia's two Sputniks, says the West technological advances are making American plans and unrealistic.

The former Secretary of Defense, for more than five years, said of military demands for more scientific research, which the Soviet satellites, are a measure of their technical competence in the ballistic missile field.

But he also believes U.S. scientists are at the same thing as they want to and that there is no need for the Russians are ahead of this country in missile development. If any country is ahead of the other, he says, it is not more than a few months before we are.

Wilson, who is a director of the American Society for the Advancement of Science, said he is in Moscow for his Michigan friends. The

senior president of General Motors corp. did admit that the American people are disturbed over the Russian satellites.

He alluded to this concern to the reporters that for the last two American men can become vulnerable to a Soviet attack.

Wilson concluded that the American people were not complacent last summer when Congress made an attempt to reduce the Defense Department budget from \$16.5 billion to less than \$16 billion.

He said he favored the higher figure—\$16 billion—was provided for fiscal 1958—and indicated that he anticipated no increase in next year's defense budget.

Wilson said people outside the Pentagon, including scientists, approval of the decision to separate the U.S. satellite program from the ballistic missile program.

When also argued "we have missile capacity; many times more powerful than the one that is being used for the entire step of the Vanguard missile."

Commenting on the dinner on the obvious evidence of Soviet satellite program, Wilson said:

Nuclear Sputnik I was Sputnik. If it was in some a military weapon. It should be clear to everyone that bigger and better satellites, great ships, or rockets to the moon will not, in themselves, solve or even help solve the problem that the free world faces today in the effort to maintain peace and avoid a nuclear conflict between the East and West.

U.S. Proposes NATO Establish Missile Defense Training Center

Paris—United States delegation to a four day conference of government ministers from NATO member nations proposed establishment of a NATO defense missile training center as well as a North Atlantic satellite for defense studies.

American proposal was one of several presented by the NATO group during a week session which has been opened by studying criticism of past and future NATO policies as well as of national defense policies presented by the United States and Great Britain. The NATO governments group comprises some 160 delegates representing various shades of non-Communist political thinking among 15 NATO nations.

Meeting tomorrow, the group is scheduled to discuss the NATO group's role in an advisory capacity. The NATO meeting, coming one month before the annual NATO ministerial meeting at which heads of all governments, including President Eisenhower, will attend, has special importance for NATO.

United States proposal of a defense missile training center was put before the NATO conference after bipartisan approval by the full American congressional delegation. Presented to the NATO group in Sen Hien Jackson (D-Wash.), the proposal reportedly has the enthusiastic approval of both President Eisenhower and his new advisors on satellite matters. Dr. James R. Killian. The proposal was well received by the NATO conference and

is expected to be implemented by the upcoming NATO ministerial meeting.

Perhaps the biggest news of the NATO meeting was an attack by the so-called "continental NATO group" against American and British defense policies. The attack was contained in a much-discussed report prepared by Arthur Gibson of Belgium and U. Geo Kaulbach of Germany, of the Netherlands.

One charge leveled in the report was that NATO ground forces were undergoing "excessive deactivation" which, due to lack of direction from SHAPE. The report also called for transfer of the satellite military training group of the De Three from its present location in Washington to Paris where it could work more closely with North Atlantic Council headquarters.

Main point of the report seemed to emphasize the feeling among NATO continental nations that the present NATO military setup does not suffice with greater than intent. Report sharply took American and British policies to task for making up to the present in modern weapons enough to permit the report to conclude that the British White Paper on defense, if carried out, would mean that continental nations would get even less than minimum support from Great Britain.

While the continental report does not necessarily present the official at-



KC-135 Sets Distance Records

Special version of Boeing's KC-135 jet tanker (above) set two nonstop distance records last week as Defense Dept. went attempting to deliver the largest of Soviet ICBM interceptors with a demonstration of Strategic Air Command capability. With Gen. Curtis E. LeMay, USAF, in command of staff at the controls, KC-135 flew 6,318 mi from Western AFB, Miss., to Ramon Air in 17 hr. 2 min. Maximum speed was 550 mph. Later, aircraft refueled by Washington National Airport, covering the 5,000 mi in 11 hr 8 min. Aircraft set a prototype of a SAC total command post (AW Nov. 11, p. 14).



Russia's Huge Mil-6 Flies

See of Russia's new Mil-6 helicopter, shown in first flight photo (above), is shown a steady climb in a packed cloudbank (the Mil-1, below), the first helicopter of the new design by M. S. Mil. Mil-6 which has five main rotors, is powered by two turbine engines. "While pilots and ground crew appearance indicate Mil-6 may have relatively fast forward speed. Packed in more than 12 min (ENR Nov. 11, p. 30).



trade of any confidential relations, it was no secret at the airport that most confidential sources subscribed to the view that Mil-6 was given such prominence because it was to set the stage for the upcoming NATO summit meeting.

American proposal on a defense missile training center was part of a \$10 million program which was offered to delegates by Sen. Jackson. In addition to a missile training center, Jackson called for a "talent development program" among NATO nations under

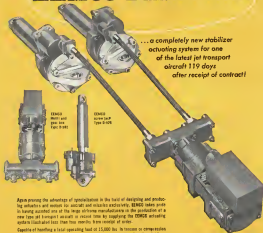
which at least 500 scientists in science would be raised annually. He also suggested that NATO sponsor an annual program in mathematical sciences which would involve handling around some 5,000 prizes among high school students. Finally, Jackson called for a European clearing house, under which scientists and engineers could be exchanged.

Poland, commenting on the missile training center, said he was thinking in terms of defense vehicles' and said that these vehicles could be supplied

without any changes in law. However, Jackson and other American delegates were harsh in their criticism of the Soviet Union during the summit, that the Makhilov Act would be modified by Congress to permit closer cooperation between the United States and NATO nations on nuclear weapons.

Gen. Schriever told reporters that a proposed NATO missile training center was "exactly what we want and what we have been trying to get for six months." He suggested that the center be set up in the Mediterranean area.

EEMCO DELIVERS



...a completely new stabilizer actuating system for one of the latest jet transport aircraft 119 days after receipt of contract!

EEMCO motor jack Type D-100

EEMCO motor jack Type D-100

Again proving the advantage of specialization in the field of designing and producing actuators and systems for aircraft and missiles exclusively, EEMCO takes pride in having assisted one of the large airplane manufacturers in the production of a new type of transport aircraft in record time by supplying the EEMCO actuating system (illustrated) less than two months from receipt of order.

Capable of handling a total operating load of 15,000 lbs. its response is comparable to both jacks, with one EEMCO actuating system providing the aircraft's stabilizer in flight. It will operate many times during an average flight, therefore loads are at maximum at all times. It will operate many times during an average flight, therefore loads are at maximum at all times. It will operate many times during an average flight, therefore loads are at maximum at all times.

The 25-inch motor is equipped with safe noise filter, magnetic clutch and brake, and an integral gear box with dual output shafts that drive the speed control motor jacks at loads up to maximum capacity. It is built up in two main parts, which is equipped with two parking stops, is 10,000 lbs. in weight at maximum. The jacks, with a stroke of 1.25 inches at 1 inch per second at maximum load 10,000 lbs. L, are equipped with an auxiliary mechanism for a control mechanism.

The power elements of this efficient EEMCO actuator system, motor with gear box and the jacks, can be adapted for other uses individually or in similar assemblies.

Drawings by EEMCO

SPECIFICATIONS

- 1. Voltage 48 volt DC
- 2. Motor 25 inch
- 3. Speed 12 inch per sec. at maximum load
- 4. Maximum load 15,000 lbs. at maximum load
- 5. Maximum stroke 1.25 inch at maximum load
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Nummer's fourth, the first U.S. long-range guided missile, is one of many other types of turbine-powered aircraft and missiles using Hamilton Standard equipment. Superior engineering, research, and development, and years of experience stand behind Hamilton Standard's leadership in production for outstanding aircraft—jet or propeller driven.

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Fairey Rotodyne Flies for First Time

Fairey Rotodyne takes off vertically at White Waltham Airfield, Berks, England. Action is powered by two Napier Eland gas-turbine engines. For takeoff, compressed air from engines is directed through rotor blades, which are held in position. Aircraft has gross weight of more than 17 tons; will carry 40 passengers or 44 tons of freight 400 mi. at 205 mph speed. Diameter of four-blade rotor is 90 ft.

Chance Vought Readies FBV-2 Prototype

Edison-Chance Vought Aircraft will soon roll out a prototype FBV-2 for flight testing and possibly approval for a Navy production contract.

Navy has plans "at the present time" to meet a production order for the FBV-2, according to Edna Helen Robert E. Dixon, chief of the Bureau of Aeronautics.

The new fighter is a modified version of the FBV-1, which is in flight test phase this winter.

Chance Vought also is working on a new fighter designated FBV-3 (AV-14), p. 35, and John Dixon said "it is our current hope" that Navy will have the leads to being both the FBV-3 and the competing McDonnell F-4B-1 designs to the flight test stage.

Chance Vought's FBV-3 is a radical, new design for an all-weather carrier fighter to succeed the FBV-1. It is a large aircraft, designed around a dual propellant approach using the Pratt & Whitney F-1 turbojet engine and a rocket motor.

FBV-3 is scheduled to make its first flight next summer.

News Digest

Board of directors of United Aircraft

Chey declared a 1957 stock dividend of one additional share of common stock. For every five shares held Nov. 21. Dividend will be paid Dec. 12. Not income for the first three quarters of 1957 totaled \$58,100,440, equivalent to 37.1% per share of common stock after dividend requirements of preferred. Sales for the three quarters were \$509,241,135, compared to \$460,007,999 for the same period in 1956. Company's backlog as of Sept. 30 totaled \$4,590,300,000, a drop from \$5,010,000 close month's earlier.

Three U.S. Air Force two jet B-66 bombers flew nonstop from George AFB, Calif., to the Philippines in just more than 17 hr. Flight is part of an operation to show that the Force can deliver a tactical striking force to help subdue trouble-free areas in the world. Flight referred to in the air all Hawaii.

Shortly after reporting a total sold aircraft worth slightly over \$1 billion in the last nine months of 1957, Boeing Airplane Co. said that "flight data"

and adjustments will be made "in view of its production schedule. Under no circumstances ordered by the Air Force, 10% of B-52 deliveries from the company's Plant 2 at Seattle, Wash., will be "in direct flight" reportedly from about seven a month to five B-52 deliveries from the Wichita, Kan. Division will be made good. Peak production of B-52s yet to be met in 1958 at the company's Transport Division in Renton, Wash., will be reached next July rather than in April as originally planned. Schedules for the Boeing guided missile will be set back two months.

New B-58 Contract

Washington-Crestone for \$11.5 million in spent production at Convair's B-58 supersonic bomber was announced last week by the Air Force. The funds will be used for procurement of long lead time items for production B-58s, based on the 30 aircraft ordered for the test program.

Prototype B-58 shows a midlength Phase II test at Convair's Fort Worth plant.

Test pilot for the program is Maj. Pennington Feltus, of Air Research and Development Command's Flight Test Center, Edwards AFB, Calif.

New Rate-of-Return Yardstick Proposed

Bureau of Air Operations proposes change in CAB rate-of-return study; fare probe will begin today.

By Ford Eastman

Washington—Increased rate of return for domestic trunk airlines over Civil Aeronautics Board's present yardstick was recommended by CAB's Bureau of Air Operations. However, in this suggestion are scheduled to begin today before Chairman Ralph L. Wiser.

The Bureau's exhibit is an independent report on a fair and reasonable rate of return for trunk airlines prepared by Paul Howell Associates, New York, financial and utility consultants.

The report concluded that for airlines to maintain financial integrity and attract additional capital on favorable terms, a reasonable rate of return for the Big Four trunklines should be between 9% and 9.75%, for the Little Eight, between 9.00% and 10.00%. In most cases, the CAB has previously held 8% return as fair and reasonable. Airlines are seeking a return of around 12%.

An increase in the rate of return, however, does not necessarily mean that a fare increase is required in order to boost or "cover" existing profits. If a higher rate of return level is approved by the Board, airlines must prove that the goal cannot be obtained without fare levels through cross-subsidy and efficient management.

Suggested Rate

- The consulting firm based its suggested rate of return on the earnings assets—cost and share revenues required to meet operating expenses—to enable airlines to:
 - Compensate existing stockholders adequately.
 - Pay bond charges.
 - Attract capital on as advantageous terms as the domestic market.
 - Maintain the financial integrity of the airlines.

In connection with this, considerable space in the report was devoted to the effect of the cost of acquiring the necessary capital to meet airline's current and future needs.

In pointed out that investors should expect to pay all costs of providing the necessary capital as well as the ordinary expenses of wages, materials, depreciation and taxes. The report stated, however, that because, economical and efficient management must use its best

efforts to keep all costs, including that of capital, at a minimum.

So far as equipment is concerned, the report estimated that the industry now has on order equipment which will cost approximately \$2 billion.

Projections made in future expansion of flight capacity and equipment will come from the following sources, the report said:

- **Debt financing**—cash borrowings
 - **Enterprise companies**—new line loans
 - **Bank loans**—for shorter, supplementary requirements
 - **Retained earnings**
 - **Sale of assets**
 - **Sales of surplus**—the general public
- Depreciation, rational earnings, and profits from the sale of aircraft account for a substantial source of capital available for replacement of little or no cost.

Long and short-term loans can be obtained from insurance companies or banks at relatively low rates, while the cost of equity financing is about six times as great as debt financing according to the Board's report.

An underlying aspect of the requirement program, the report said, is that more of the airlines already have completed their financing requirements for the next couple of years through

debt financing at relatively low interest rates.

An interesting observation to be drawn from this advice, however, the report pointed out, is the confidence which airline managers have in the fundamental long-run position of their business and the readiness which is shown to keep the cost of capital within reasonable bounds.

The higher cost of equity capital can be viewed as part of the low dividend payout which is not popular with stockholders. To maintain their current requirements, however, airlines generally have not relied on equity financing, but it may be required in future financing. As a result, the suggested rate of return was determined by weighing the cost of debt and equity financing for the industry.

Rejects Operating Ratio

The Howell report also rejected airline's contention that an operating ratio analysis of rate of return is inappropriate. It should be used to determine rates. Current ratios that because airlines have a high operating ratio and a need capital, however, that the conceptual approach to reasonable rate of return is inappropriate. Howell includes three reasons for rejecting the operating ratio approach:

- **Cost of capital and its savings** place more emphasis on the cost of capital than on the nature and character of airline operating ratios and capital structure.
- **Any use of the so-called operating ratio approach must account for the airline's certain savings on investment.** The question would seem to be, not what is an appropriate operating ratio, but what should be the cost result.
- **Debt and equity financing** are primarily concerned with the amount of dollars they can raise relative to what they put in.
- **Operating ratio approach is essentially a "one plus plus" concept.** The one plus concept has been interpreted as the cost of a new airline to operate in efficient and economical operation.
- **Operating ratio approach as indicated by current statistical exhibits is incomplete.** No objective data are presented to show what the rate for an



First Electra Rolls Out Ahead of Schedule

Lockheed Aircraft Corp. last week rolled out its first Electra turboprop transport. There was a smooth dash of production schedule. First actual production flight in May, 1958. No new test flight date has been set; original date was Jan. 31, 1955. Electra has a length 104 ft 11 in., wingspan 104 ft 11 in., height 30 ft 11 in., length 104 ft 11 in., wingspan 104 ft 11 in., height 30 ft 11 in.

current should be said who it should be at this particular level.

- **Administrative procedures** would not be involved in using the operating ratio, but as more fare changes would have to be made for the use of operating ratio as a cost of capital approach.
- **Operating ratio approach** could result in release of business and not to its officers; the amount of capital dedicated to the supply pool of this capital.

American Protests Capital Subsidy Bid

Washington—American Airlines last week pointed against a Capital Airlines request for federal subsidy (AW, Nov. 11, p. 36) as grounds that a patch of financing competition with government funds it "is likely to be unfair."

American cited the Civil Aeronautics Board for its opposition to the subsidy, whether it is in the public interest for the government to subsidize an airline which competes directly with another airline.

Earlier this month, Capital had the Board's request immediately dismissed as it is in form of subsidy because of a critical financial condition.

C. R. Smith, American's president, and his company do not appear to have been asked to comment on the matter that could not otherwise support an airline service. He said that, in effect, Capital Airline is asking the federal government to subsidize its operation and guarantee a profit. "The better to expect it to compete with airlines which receive no subsidy."

American pointed out that a high

percentage of airline service provided by Capital Airlines, the airlines operated by American and other companies and added:

"This proposal, in the opinion of American, raises a basic question of public policy. It is in the national interest to get substantial subsidy against unsubsidized airlines."

Excursion Fare Use Outlined in Survey

New York—Transit 15 day excursion fare was used to business travelers about as much as pleasure travelers last winter, a study by New York Air Transport indicates.

Of scheduled passengers departing New York during the November through March period, 2,125 traveling for business purposes and 2,125 traveling for pleasure bought minimum plan fares.

Another 412 of the excursion fare passengers were traveling for personal reasons.

Total of 4,560 excursion fare passengers was 7% of the 56,800 scheduled passengers during the period, according to the Port Authority's figures. Transit class passengers accounted for 35% of the total, and first class passengers the remaining 52%.

Of American Airlines' survey is based on questionnaires completed by 70,400 passengers aboard 1,060 flights leaving New York for various destinations including Puerto Rico. A complete analysis of the off-peak days of the survey will be issued in the near future, followed by an analysis of the year as a whole.

pleasure trips and 56% were traveling for personal reasons.

American Airlines passengers totaled 50,740 for the five months. Foreign residents totaled 75,500.

The Port Authority's figures were included in a preliminary report to airlines on the results of the off-peak season of a survey begun in April, 1956. Question results were reported earlier (AW, Aug. 26, p. 18).

Largest percentage of American Airlines passengers traveled for business purposes—25%—spent two weeks on their trips. Traveling passengers' trips lasted longer, 23%, the greatest number, took four weeks. But 15% of the travelers for other pleasure purposes, such as visits to friends or relatives, stayed only two weeks. That was the largest percentage in the "other plan" group. Greatest duration of trips was reported by business for personal affairs, at about 27% among the American residents stayed 12 to 24 months.

American residents traveling for leisure purposes totaled 7,500 during the five months. They were substantially the "other pleasure" business, who totaled 17,000, and be business passengers totaling 19,500. The remaining 6,780 passengers were attending to personal affairs.

The Port Authority's survey is based on questionnaires completed by 70,400 passengers aboard 1,060 flights leaving New York for various destinations including Puerto Rico. A complete analysis of the off-peak days of the survey will be issued in the near future, followed by an analysis of the year as a whole.

Continental Confirms

Washington—Continental Air Lines last week confirmed the Civil Aeronautics Board for a line income amounting to an average of 75% over average profits against its costs of operation.

Continental said although its report makes clear it would the company received a low level of a half million dollars on its line DCA operations. The line coupled with the present downward trend in national economy will not save Continental a substantial amount on its operations for 1958 over the previous year, the airline said.

The increase, if granted, would bring a return of about \$400,000 a year. Continental said. Approximately 65% of the income is related to the income from the airline's local service operations controlled by the integration of that system with Continental.



SKETCH shape of TWA terminal roof design is without its steep side slopes seen. Backs of skylights separate the first thin concrete vault housing ducts and angled arm of the proposed Midway lobby. Slightest sloping direction of wind tunnel and ducts in area, under sun at left enables baggage claim area. Restaurant patron will look out of glass walls under the wing vault.

TWA Picks Futuristic Terminal Design

By Glen Garrison

New York-Times World Airlines plans a \$12 million passenger terminal of futuristic design to be completed at New York International Airport in early 1969. The terminal, one of seven individual rather than combined ones, features a striking vaulted concrete roof over the main building of its complex.

The TWA terminal will handle 14 Boeing 707 jet transports at once, and it has been designed to provide passengers with new comfort and convenience in its amenities and service. Among its features are two ramp bridges where passengers will not have to board these aircraft. It features equipped with moving sidewalks will

connect these ramp buildings with the main structure. According to present plans, passengers will still climb into their planes from the open ramp and their baggage will arrive by cart.

Other features of the terminal:

- Violet and check-in complex 178 ft long, located at street level near the transit dock.

- Central information desk with large screen and departure board probably electronically controlled.

- Main waiting area equipped from other aircraft and designed like a plush comfortable lounge that passengers can watch airport activity through glass walls. A second information board will keep them posted on flight times.

- Self-service baggage belt 100 ft long, situated at street level.

- Electronically controlled entrance and exit doors.

- View of TWA's operations through a window located near baggage claim area.

Heart of the highly original terminal building is the central unit covered by a data concrete shell formed by four intersecting vaults. Shell spans 160 ft, and air two levels vaults into each corner 54 ft high at their apex. Vaults are joined on four points.

Two projecting arms on either side of the central unit are single-story staircases containing waiting and check-in area (left from street side) and the other containing baggage claim area.

Information counter, shops, restrooms and main waiting areas are under the shell, with the counter at street level and other elements tucked below and contained in a bridge.

In announcing plans for the terminal, TWA President Carter L. Burgess said the structure is designed to fit the efficiency, functionality and drama of the aviation era ahead. The scheme hopes to make it the showcase of its own style, Burgess said.

Architect Eric Saarinen said his primary considerations in designing the terminal were two: to provide a natural sequence of movement for passengers, making their arrival, as painless as possible, and to express the purpose of the building in its design.

An air terminal is a place of transition, Saarinen said, and should look like one. Most air terminals today are box-like, plain, the architect said, whereas at the part the terminal, have built some beautiful structures.

The 12-ft high bridge connecting the main building with the ramp will be topped with glass and lighted glass a

new level to provide glacial visibility at night. Each finger will contain a 12-ft-by-10-ft moving sidewalk, in each direction and a non-moving passenger for those who prefer it. At the end of the finger will be several boarding areas in each of the two buildings. The ramps will be built around air-bridged garden areas and can be divided to separate coach and first class passengers on combination flights.

Passenger Protection

Although passengers will be exposed to the weather in boarding aircraft, TWA is studying methods of protecting passengers from weather, according to George Clay, vice president, administration.

These include the movable bridge type of device which Clay said is still in the experimental stage. The retractable canopies and awnings, which Pan American Western Airlines plan to incorporate in its Midwest terminal is not considered satisfactory by TWA because of cost problems of its being at the building.

TWA generally plans to let its jets in and out of the terminal rather than use more means of towing. The terminal design includes a fleet base from each ramp building.

Actual design proposals against jet noise, Saarinen said, is to use "a car" with thick windows and rubber vibration but the problem will exist at all airport terminals.

The two ramp buildings have been designed so that a second story can be added for plane-level boarding if devices such as loading bridges are used, Clay said. Also, the ramp ends of the finger can be adjusted to a second story level of connection with the buildings.

Construction Phase

Construction of the facility is planned in two stages. First phase is scheduled to begin next April with mid-1971 completion. What will be the master plan building containing the ticket counter, an adjacent lobby, and the ramp house at that finger and Central unit and after unit building. Sign and ramp house will be completed in early 1969, according to the plans.

The staging depends in part on Port of New York Authority relinquishment of space in the TWA terminal area. The airport's present passenger terminal sheds the area on one side. Adjacent to its other side is the Port Authority's International Arrivals Building with its ramp buildings for foreign flag aircraft.

TWA is very happy with the design, the \$155-million odd-shaped terminal area at the airport. The airline's favorite building will enter the eye of passengers approaching terminal city on the main roadway entering the opposite propellers of the oval.

Underground facility system will serve the core of the new terminal, according to Clay. However, most remaining options are expected to take place in TWA's hands.

Airline Penalty Plan Trims No-Shows

More-a reduction of 49% in the number of no-shows since September, 1916, when domestic airlines introduced their three phase no-show plan, was reported by the Air Traffic Conference last week.

Findings of the no-show survey are based on quarterly sampling period, the latest of which was conducted from Oct. 1-14 covering 570,000 passengers as 11% of the total monthly domestic traffic.

The report indicated that actual no-shows had increased by 56% on coach flights and 20% on first class flights since the no-show plan was first adopted. On this account, 26% of the passengers who did not cancel space were credit on another flight.

The 55 penalty, a charge imposed on passengers who fail to cancel their reservations, has been raised 2,500 since August 15, 1957, when first class of the plan was first adopted. The no-show plan was adopted July 14, and the first step in the program (maximum limit on ticket penalty, began Sept. 15, 1959).

Passengers using the penalty amounted to 97% of all domestic coach passengers and 49% of first class travelers.

The conference elected E. G. Chase, senior vice president for TWA World Airways, as its president for the coming year. C. M. Britt, vice president for Western Airlines, was elected first vice president and Nelson D. Fry, assistant vice president of Capital Airlines, was named second vice president.

Hughes Stock Case Strikes Legal Snag

Washington—Attempts to settle the Howard Hughes-TWA World Airlines Alaska-Norfolk Airlines stock case has struck a legal snag.

Civil Action Number Board Resolution Paul N. Pfeiffer has tentatively reported a proposed settlement and deferred all parties to show cause why the hearing should not be required for testimony of Pfeiffer here. The proposed settlement is to be made by the hearing through the establishment of an amicable voting trust for beneficially owned shares of Alaska common stock held by Hughes. Pfeiffer and the parties' desire is the establishment of such a trust in

the apparent fact that Hughes' Alaska voting shares are not free to go into the trust, and, therefore, the trust is not available at the will of Hughes as a matter of law.

Counsel will be granted until Nov. 25 to submit to the Federal court a proposed showing cause why the hearing should not be required for the testimony of Hughes.

Pfeiffer and that it substantiates an agreement for the hearing will be recommended Diet 9.

CAB Prepares Probe Of Missing Airliner

Washington—Civil Aeronautics Board said last week it would conduct an investigation to determine an effort to determine the fate of the Pan American World Airways' airliner lost over the Pacific on Nov. 8.

The airline's last reported radio transmission was made at 10:47 P.M. in the plane passed the inflow mark. The flight from San Francisco to Honolulu.

The plane a Boeing 377 Stratocruiser carried 16 passengers and a crew of eight.

The CAB investigation team will consist of William E. MacNair, flight operations specialist, and A. R. Hallinan, airworthiness inspector, both of Washington, and Leon D. Gackleback, Earl R. Mitchell, both of Oakland, Calif., and Arnold E. Hadden, Santa Monica, Calif.

Constellations Boost Flying Tiger Traffic

New York-Flying Tiger Line reports highly successful midline results with its new 41-Constellation flight service. The rapid carrier began phasing out its older 747 and DC-8s last month and now operates only Super H Constellation.

During the third week of October, traffic was up 44% over the first week and 74% over the second week, according to Flying Tiger Line. New service included through service between the Pacific Northwest and New England, a nonstop flight from the West Coast to New York.

Revenue gain in the New York-New Jersey area was 70% during the first week of all-Super H service over the first week of October.

All terminal cities on the carrier's routes have been placed on increased aircraft routes and the new all-Constellation Flying Tiger reports, providing new meaning delivery to the East Coast from San Francisco and Los Angeles and westward to meet the delivery of most stations.



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Flight Engineers Bid for Jet Age Role

By L. L. Doty

Washington—Flight engineers are paving their hopes for a job-a-lot into a program that is sure to meet strong resistance from cockpit pilots.

The growing conflict between the Flight Engineers' International Association, representing about 90% of airline flight engineers and the Air Line Pilots Assn. has been smoldering for three years. It began to come to a head last November when the pilots adopted a resolution that would strip their own members on jet transports to be qualified pilots (AV Nov. 14, 1966, p. 35).

Full scope of the struggle between the two unions will be brought into the open for the first time in January when members and supporters are scheduled to the Civil Aeronautics Board on a proposed rule governing flight engineer certification.

The basic issue—whether flight engineers will retain their present professional status as crew members on jet transports without receiving jet pilot equivalencies—will be determined finally in the collective bargaining tables when airlines begin negotiations with the two unions on turbine aircraft operations.

Engineers Win Round

In the meantime, Flight Engineers' International Association has taken a big step toward holding its own before position in a result of a contract signed with Pan American World Airways (AV Nov. 4 p. 25). A joint interpretation of the agreement which runs until 1968 reads:

It is the specific intention of the parties that Pan American shall not assign a pilot-engineer, as the term is understood in place of a professional engineer to perform the engineering function."

On the other hand, Air Line Pilots Assn. will have gained a significant point as, in later if the proposed GAU rule on flight engineers is adopted. The proposed revision of Civil Air Regulations includes an amendment stating that applicants can qualify as flight engineers if they "have had at least 500 hours of flight time as a pilot or commander or 400 hours of flight time as a copilot, at aircraft having four or more engines rated at least at 500 hp each or the equivalent thereof in the case of turbine-powered aircraft."

The amendment if adopted will give the pilot group legal backing in its demands that pilots be included in third class members. However, the second proposal would not exclude present regulations which permit trained

mechanics to qualify for flight engineers without actual pilot experience.

Pilots anticipated an outburst from the flight engineers when the third crew member rule was first introduced as a resolution and attempted to restrict the blue by emphasizing that engineers who wished to qualify as pilots would have ALPA support. The pilots also stressed that the resolution applied only to turbine-powered aircraft and would not affect engine crew members assigned to piston engine aircraft. Really, they stood in this.

Pilots will place major importance on jet flight planning, to fit jet transport into the inadequate airport buffer control and navigational facilities. At jet altitudes and speeds, no problem is more prominent than jet crew planning. "No time is available for a flight trouble-shooting and tool-in error solution to emergencies."

The position taken by the flight engineers sharply contrasts this point of view. In a detailed paper prepared by IFA President George Perry, Jr., the association in Trans World Airlines engineers stress that increasing problems of air traffic control will add to the electronic complexity of aircraft within the air.

Even without "one man" jet specific with the same as electronic complexity has occurred to the Air Force—that is, no radar, the pilot workload alone is causing the burden on an electronic technician."

Engineers Reply

In response, ALPA charges that many flight engineers claim will be charged on turbine aircraft because of the absence of such piston engine crew control characteristics as manual pressure, propeller rpm, mixture settings for percentage leaning or re-

verse mixture monitoring. Perry has this to say:

It has been maintained that the operation of the jet transport is simpler because there are fewer controls, switches and dials in the cockpit. As more and more of the cockpit work for the most precision of transport are handled it becomes more apparent that this argument is spurious. The odds:

Because of the increased sophistication in turbine aircraft and the extremely high fuel consumption of turbine engines, the function of the flight engineer in operation and maintenance, at flight with regard to engine operation and control procedures will be more vital to the safety and efficiency of flight and more involving in engine events for electronic, electronic and mechanical knowledge than ever before."

Jet Engine Functions

With minor exceptions as to control operational duties of a flight engineer on jet aircraft:

- **Fuel management.** Flight engineers will be required to keep fuel-burns fuel logs and maintain computation of engine of growth because of high fuel burn on jet aircraft. Mismanagement of fuel will cause lateral fuel imbalance and a center of gravity shift on an operating aircraft under emergency conditions.
- **Powerplants.** Flight engineers will be required to monitor engine instruments during takeoff and landing. Engines, which are difficult to detect because engines are centrally located on each instrumentation as rpm, fuel flow, and exhaust gas temperature can be almost normal for a considerable length of time after failure.
- **Powerplant icing.** Monitoring of fuel pump temperatures by the engineers will



Caravelle in Varig Markings

Varig Airlines markings are shown on Sud Aviation Caravelle jet transport which the Brazilian carrier has ordered. There are no option bodies the two engines.

Quicker, Simpler (and that means GHEAPER) maintenance with the ELAND

EFFICIENT AIRLINES are thinking more and more in terms of propeller turbine propulsion for short and medium haul services. In this field the Napier ELAND has a number of outstanding advantages, among them being its extremely low maintenance costs.



CHEAPER ON THE GROUND

The ELAND engine consists of four main sub-assemblies: reduction gear, compressor, combustion chamber and turbine. Each sub-assembly is a self-contained unit that can be removed and tested separately. This type of construction makes for easier and quicker maintenance and gets the maximum working life from each component.

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The ELAND is designed for economy. A Caravelle with piston engines will carry a full payload 300 miles, but the same aircraft, after conversion to ELAND engines, is able to extend its range to 900 miles and increase its speed by 35 m.p.h. The same 3,000 h.p. that is developed by the ELANDs does the same amount of work in half the time under operating conditions of extreme temperatures and altitudes. This economy and flexibility can be expressed in substantially lower operating costs.

PASSENGER APPEAL

Passengers need no technical knowledge of aircraft to form automatic preferences. Once they have experienced (or been told about) the smoothness and quietness of turbo-prop flight, they will tend towards piston engine aircraft whenever possible. In addition, the greater simplicity and reliability of the turbo-prop engine can factor that weigh heavily with the passenger and influence his choice of airline.

TO BUY OR CONVERT?

While the final decision depends on a number of variables—such as the life of the aircraft, its book value and its revenue earning power—it is almost always sounder economics to convert an existing piston engine machine than to buy a new solution. An ELAND conversion can be carried out for less than a third of the cost of a new aircraft with the certainty that this expenditure will be quickly recovered by the increased earning power.

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in solution to prevent engine performance loss or damage caused by icing.

- **Fuel dumping.** Higher engines will be required to assist in the safe conduct of fuel dumping operations. Potts adds, "mistakes can arise from partial failure of the chemical system. The pneumatic system, where in the hydraulic system which could conceivably develop into a failure of various proportions requiring fuel dumping but because of the pressure of a flight engineer could be so mixed as to prevent release continuation of the flight is possible."

Potts admits adjustment of cruise power is a simple matter on jet engines and that fuel can be adjusted easily to give desired indicated airspeed. He adds, however, that it is not ready and can not be determined easily, though.

On this point he states that an aircraft which can adjust engine thrust to produce various maximum thrust (Vmax) and supercruise fitted fusages or coatings can come faster drag at higher airspeeds. He adds:

"The one check the flight engineer must have on the thrust required to produce which engine speed will be the check performed in flight by the flight engineer."

Potts points out that since there is no advantage to determine thrust at altitude, the information from the engine's engine instruments must be integrated with indicated airspeed from an instrumentation and can be precise. A third figure is derived by comparing this factor with engine power charts. The first instrument he refers to is the pressure ratio as engine pressure indicates exhaust gas temperature, exhaust high pressure, compressor pressure, pressure compressor ratio and the fuel flow indicator.

Potts says that if a flight engineer were to discuss through this cross-checking of cruise performance with engine instruments that a Boeing 707-320 can fly 10 to 15 mph, compared to a four-engine jet, 50,000 ft. in fuel costs in one hour.

The TWA president states in his report that airlines will operate jet aircraft at the Mach number of maximum cruise speed, which will be higher than the Mach number for best range. At the light Mach number, small variations in air speed or temperature can cause variations in specific range of 10% to 15% and add.

It will be the responsibility of the flight engineer to monitor the details of the cruising operation and compare the performance of the aircraft with curves provided by the manufacturer. The determination of equipment and schedules at an altitude, temperature and speed is somewhat more complicated than similar operations for piston engine aircraft and more power will have to be added at least some even.



Mockup Shows DC-8 Lounge

Lounge arrangement in Douglas DC-8 mockup exhibits light, modern appearance of seats and table. One half of the lounge is visible. Above these mockups are mockup overhead bins, molded into structure. First class area at the DC-8 was scheduled for 1959.

21 months, these three checks will take considerable amount of cockpit time."

Accordingly, Potts stresses that if a transcontinental Boeing 707 flight exceeded the desired Mach number in 15, fuel reserve for holding would be cut by 10% and range at 20,000 ft. after reaching destination by about 75 mi.

Examiner Urges More Flights at Ft. Worth

Washington—An survey to Ft. Worth is adequate in some respects, but additional flights to a number of points are needed, according to Civil Aeronautics Board Chairman Leslie G. Douglas.

In an initial decision in the Ft. Worth investigation Douglas said the Airlines that a third of a million potential passengers were being left out of the service provided at Love Field in Dallas has not been authorized in the evidence. Actual loss, he said, there probably ranges from 20,000 to 50,000 passengers annually.

Douglas said that Love Field, because of Dallas' greater population and its importance as a connecting point, has a greater passenger potential. This results in a greater number of flights with a wider choice of equipment and schedules. It would appear, the examiner added, that unless the schedules at Ft. Worth are extended for flight times that are available at Love Field, a large number of true Ft. Worth passen-

gers will continue to use Love Field.

The examiner's complete findings are:

- Service, equipment and facilities provided by American Airlines are the same between Ft. Worth and San Antonio, Chicago, Oklahoma City, Los Angeles, Tulsa, San Francisco, El Paso and Washington.

- Service of American Airlines is inadequate between Ft. Worth and New York in that it fails to provide nonstop service, and between Ft. Worth and Houston, Texas, in that it fails to provide continuous service.

- Service, equipment and facilities provided by United Airlines are adequate between Ft. Worth and Houston, San Antonio, Chicago, Oklahoma City, Tulsa, Austin, Kansas City, Amarillo, Corpus Christi, Denver, Wichita Falls, Minneapolis, Waco and Omaha.

- United's service is inadequate between Ft. Worth, New York and Washington.

- Service, equipment and facilities provided by Delta Air Lines are adequate between Ft. Worth and New York, Washington, St. Louis, Atlanta, Jackson and Birmingham.

- Delta service is inadequate between Ft. Worth and New Orleans.

- Service, equipment and facilities provided by Continental Air Lines are adequate between Ft. Worth and Houston, Ft. Worth, St. Louis and Waco.

- Service, equipment and facilities provided by Central Airlines, Shreveport and Tulsa/Texas Airways are adequate between Ft. Worth and the various points to which the service is authorized.

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parable to today's tactical aircraft—will permit more thorough and effective airways inspections.

For SAC: The Strategic Air Command depends upon high speeds to rush high priority cargo from its headquarters to its activation bases. The new Lockheed Jetstar can transport critical parts for bombers and navigation instruments to SAC bases—both jet speed (but at much lower cost than the big jets).

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GEORGE DEDMON, Lockheed Aircraft Corporation, Marietta, Georgia

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ELECTRONIC countermeasures (ECM) techniques and devices are combined to decrease the effectiveness against variety of surveillance and attack guidance radar at first ranges like this one operated by Redstone Jet Center Air Force sponsorship.

Exclusive Report on Countermeasures: Part I

Avionics Fights Its Own Silent War

By Philip J. Kline

New York—Electronic countermeasures, the silent, highly secret weapons of electromagnetic detection, disruption, and deception, have become a crucial factor in modern warfare.

Any radar which captures radar, radio or infrared for guidance can be degraded by electronic countermeasures. Missiles which formerly relied on, gas for detection are fast shifting to electronic countermeasures which are far more effective against radar directed interceptors and radar guided missiles.

Remarkable Growth

Like war the Defense Department will spend close to \$400 million for electronic countermeasures—more than the U.S. spent for those during each five years of World War II. The remarkable growth of electronic countermeasures often reflects the state of civilian industry dependence upon radar, radio and infrared for target detection, surveillance, weapon guidance and communication.

Electronic countermeasures action by an enemy, designed to obscure the sit-

ing, confuse the defender and intercept vital communications, could be the first harbinger of an all-out attack. Jamming of Japco Defense Earth Warning, later radar would constitute an immediate declaration of war, some big Air Force officials say.

Who's Who in Countermeasures

Aerospace companies known to be active in the field of electronic countermeasures include the following: Lockheed Westinghouse Laboratories; Cals Laboratories; Collins Radio; Electronic Countermeasures Inc.; Electronic Systems Co.; Emerson Radio & Television; Engineering Research Corp.; Fairchild; Federal Telecommunications Laboratories; General Electric General Mills; Gulton; Hulse Research & Development; Hoffman Electronics; Itek Industries; W. L. Manna; Miles; Motorola Radio Co.; Radio Corporation of America; Raytheon; Westinghouse Laboratories; Sperry Rand; Sperry Rand; Westinghouse Laboratories; Westinghouse Electric Corp.

Directed electronic warfare is being waged today, and every day, as both sides probe the other's electronic defenses. Objective is to determine location of radar and radio transmitters and involve their operating characteristics in order to develop equipment suitable for jamming or even a shooting war. This probing usually takes place without radar because electromagnetic radiation does not obey at national boundaries. Sometimes a probing airplane at substantial distance too close to a foreign border. If the operation is in a trigger-happy mood, gun, laser and it is a small international incident.

Men are lifted, planes are lost, but the probing goes on.

Types of Countermeasures

Electronic countermeasures perform a variety of missions, but generally are classified into one of three categories: **• Reconnaissance:** electronic countermeasures are used to detect and analyze electromagnetic radiations from aircraft, missiles and other airborne vehicles as well as from fixed radio radar installations. Objective is to pinpoint their location and to determine type of elec-

tronic communications which must be developed or employed to down the enemy that effective use.

• Passive electronic countermeasures: complex devices and techniques which do not themselves generate electromagnetic radiation but change the nature of the enemy's radiation back to the enemy radar or seek to prevent its action. Best known example is "chaff," thousands of strips of tinfoil dropped overhead by bombers during World War II to create spurious radar echoes that obscured the echoes from the bombers and confused the enemy radar operators.

• Active electronic countermeasures: generate electromagnetic radiation intended to interfere with enemy radar or radio signals and/or to confuse the radar or radio operator. One type of active electronic countermeasures commonly is called "jamming."

Important Side Effects

In addition to these primary objectives, electronic warfare can produce terribly important side effects. For example, electronic countermeasures caused by Allied bombers proved to be effective in jamming Germany's vast network of air defense radar that in late 1944 (according to a U.S. government estimate) nearly 90% of Germany's high frequency intercepts were jammed by jamming techniques.

Even using a more conservative figure of 50% this means that roughly 4,000 German interceptors were occupied in searching for electronic countermeasures that had been fed by less than 400 American interceptors who had developed the electronic countermeasures.

When an Allied bomber equipped with a search radar began the first to speedily at electronic frequencies emitted in Germany, that country's interceptors were not busy searching for electronic countermeasures problems in which the war ended in such a short time, where it would have been extremely effective.

The importance of reconnaissance in



MISSILE can be loaded by attaching special selector, like Launching Lane shown on left of picture, which give very strong radar echo, making small ones look like huge bombers.

conventional military operations is well known. Electronic reconnaissance is even more important because of the considerable time required to develop active electronic countermeasures with which to counter a new enemy radar or radio technique.

Fortunately the task of electronic countermeasures is somewhat easier in certain respects because electromagnetic radiation propagates in all directions except at the higher frequencies. Even at these frequencies there is considerable energy that spills outside a radar or radio communications beam. (One important advantage of the wide dispersed nature of radio waves is that it is a disadvantage of its cooperative principle.)

Most of all electronic countermeasures reconnaissance equipment is the one for (most) sensitive receiver which can be rapidly turned over a wide portion of the spectrum in search of electromagnetic radiation. Suitable detection finding means for pinpointing the

direction to the transmitter is also generally provided.

Recently developed tracking wave radar, which have excellent sensitivity and can be turned quickly (electronically) over a relatively wide frequency range, have proved a great boon to electronic reconnaissance. As even more recent developments, with the greater precision is the Maser (laser) amplifier which has been shown recently to be a factor of 100 or more.

When electromagnetic radiation is intercepted, automatic direction finding techniques provide information on bearing to the transmitter. If the signal is from a radar, it can be analyzed further. For a pulse radar signal, for example, the "structure analysis" is chosen determination of operating frequency, pulse repetition rate and pulse width.

Automatic Analysis

In World War II electronic countermeasures reconnaissance often in the form of a intercepted signal as displayed on a cathode ray tube and analyzed by the countermeasures operator. In newer equipment now in use, this structure analysis is performed automatically and rapidly. If the intercepted signal is a pulse-coded form of communication, such as data link, analysis of the message structure can be extremely difficult.

Generally speaking, the range at which a radar transmitter can be detected is considerably greater than the effective target detection range of the radar. The reason is that the energy reflected back to the radar is only a small fraction of the energy that reaches



CHAFF, consisting of thousands of tinfoil strips, is dropped from aircraft to produce spurious radar echoes or interference effect which obscures bombers from ground radar.

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the target and its reconnaissance process.

Any airplane, missile or other vehicle that employs radar for navigation, guidance, bombing or surveillance runs the risk of giving away its position by tell-tale radiation. This explains the potent emphasis on radar system for guidance, navigation and bombing and the use of reflected or passive (non-radiating) radar for surveillance. These newer techniques do not require electro-magnetic energy, thus provide for greater security.

One of the first U. S. airborne electronic reconnaissance missions against ground radar took place early in 1945 against Japanese-occupied Koko in the Marianas. Reconnaissance photos of Koko showed two large structures had been erected which resembled a low-frequency Japanese radar captured in Guadalcanal. An Air Force B-24 was outfitted with electronic countermeasures receivers and flown close to Koko. Two unknown radar signals were detected and traced to the suspected site.

Recently captured U. S. aircraft subsequently called "Ironch," were captured shortly afterward in North Africa to spot German air defense radar. Later in 1945 Navy patrol bombers were enlisted with reconnaissance missions equipped with radio direction finders which proved extremely effective in spotting radar equipped German U-boats.

Radar Gaps

Electronic reconnaissance is valuable also for spotting gaps in radar coverage and in determining effectiveness of counter radar systems. For instance, reconnaissance of the Japanese Koko radar revealed that its vision was blocked in one quadrant by a large volcano mountain. With this knowledge, U. S. aircraft could approach from that direction and stage surprise raids without being spotted by Japanese radar.

A clever enemy will not necessarily

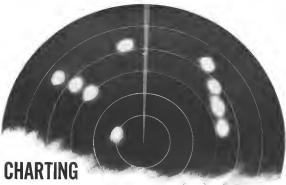
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to order close surveillance without an audible change in the transmitter characteristic usually associated with aerial search-surveillance.

Use of Subterfuge

Electronic countermeasures require considerable skill and ingenuity on the part of the electronic countermeasures operator because things are not always as they seem. For example, in the fall of 1940 the Germans set up a powerful radio transmitter whose apparent purpose was to broadcast Britain's propaganda.

In reality the transmitter had a more important mission: to provide guidance for German bombers. Shortly before a German raid, its beam was switched to about 3 deg. without interrupting the steady stream of propaganda. German bombers flew down this radio beam to where it intersected the beam from an other German transmitter directly over London, then dropped their bombs.

Londoners who were tuned to the German station began to notice that the signal strength (volume) increased sharply just prior to an air raid and used this as a warning to take shelter. Subsequently, pylons outside London observed that the signal strength dropped sharply just before an air raid.

When the British discovered the secret, they developed two counter-

measures for doing the same. One was to radiobroadcast the German transmission continuously from an aerial.

The other was to use a directional antenna for the broadcast which effectively deflected the intensity of the beam to a point over the channel. The latter prevented the Germans from knowing that their secret had been discovered with the result that many bombs fell in the channel instead of in London.

Passive Countermeasures

First recorded use of chaff, or "weather" as it was known at first, took place in a British intercept raid on Hamburg in July 1941. The month is quoted a government report, "an spectacular Royal Air Force loss was not due to a small fraction of them, captured in previous attacks. German radio operators were bound to believe 'The planes are doubling themselves.'"

This passive electronic countermeasure was extremely cheap and easy to use. It consisted of small bundles, dropped from bombers, which opened and sent thousands of strips of metal flaring down. Each strip was of such length that it was resonant at the frequency of the German radar, thereby changing a ray color. Collectively the

thousands of metal strips presented a target (chaff) which was larger, brighter than the bomber itself.

The chaff served both to confuse the radar operators and to mask the bomber from the enemy's search screen.

Obsolescence Chaff

With increased speeds of radar choppers has decreased the radar use of conventional chaff. The very significant difference in speed between the flaring chaff and the supersonic bomber makes it easier for radar operators to distinguish between the two. Furthermore, the bomber moves about so rapidly that it may leave its chaff wake unobserved.

A partial solution to this problem is to deposit chaff from aerial rockets fired ahead, behind, above or below the bomber. A more sophisticated approach is to use a pocket missile chaff designed to send a constant stream of chaff to the bomber to provide a more effective interference. Such chaff dispersing techniques previously are under development or in operational use. They are being designed to greatly change repeating frequencies to a different portion of the spectrum. Chaff effectiveness is reduced because the length of the tail strips is no longer resonant at the new frequency—

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REGULUS II Supersonic surface-to-surface missile. Preparedness to equip Navy's new nuclear-driven submarines. One of Vaught's new weapon system capabilities.



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ELECTRONICS Center of much of Vaught's recent pioneering. Vaught's electronics team now is nine times larger than in 1950. Promotes further advances in reliability, sensors design and stabilization.



MACH 2-PLUS FIGHTER Due soon from Vaught, an all-weather, missile-carrying, carrier-based fighter that can exceed Mach 2. Will provide performance normally reached only by research aircraft.



INERTIAL GUIDANCE Vaught is adapting inertial guidance for a new role in ship-based missiles. Goals in this unique project include longer-range guidance, finer terminal accuracy, ability to handle quick changes in launching position and variations in course.



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laid radar sets can confuse an intercepter in radar guided mode that employs constant scanning of its beam to obtain among or among information on target position.

The art of camouflage is as old as warfare so it is not surprising that considerable thought has been given to the possibility of techniques which would make an object invisible to radar. Despite periodic claims of "boom boom" that they have discovered a point which "blinds" radar, there is an indication that a feasible technique applicable to high-speed aircraft or missiles has yet been conceived. Most experts in the field doubt whether it ever will.

Radar "Blinders"

To make an object invisible to radar, it is essential to prevent energy from being reflected back to the radar antenna.

There are two general types of "radar blinders":

• **Destructive interference.** This type, analogous to the anti-reflection coatings applied to optical lenses, produces a reflection of radar energy from its outer surface which is opposite in phase to that reflected from the outer surface of the coating, thereby producing destructive interference between the two which greatly reduces the energy reflected to the radar. Germans developed such coatings for radar camouflage of U-boats during World War II. The destructive interference coating has the serious disadvantage of being extremely frequency sensitive. While it can provide radar camouflage at one radar operating frequency, it is ineffective against radar at other frequencies.

• **Energy absorbers.** This type tends to completely absorb (and dissipate as heat) incident radar energy. Germans also developed an absorbent radar camouflage consisting of a 1/2 in. thick sandwich of alternate layers of conducting and dielectric material. The foam-type plastic had a dielectric constant nearly the same as air, provided good radar energy absorption over a fairly broad band (about 4 to 12 cm.). Several companies currently produce absorbent materials for being the inside of rooms used to test radar and radio antennas. One material, produced by Emerson & Cuming, reportedly absorbs 99% of incident radar energy over a sixteen wide frequency band. Material suitable for operation at X-band and above absorbs about 94% in thickness.

It is difficult to conceive of a high-speed aircraft or missile whose fuselage is encased with sponge material of this type for camouflage against radar. A more feasible possibility, particularly for missiles, would be to use a high-temperature ceramic with dielectric constant approaching that of air, whose

outer surface was lined with absorbent material to dissipate the radar energy.

One of the most challenging areas in the field of electronic warfare is the development and operational use of active electronic countermeasures and electronic counter countermeasures. Both subjects will be discussed in the concluding article of this series in a subsequent issue of AVIATION WEEK.



• **Dark Bombing Computer—Los Alamos, sponsored dark bombing computer for nuclear weapons which weighs less than 10 lbs. is being developed by Magnoheter Lowsky Co., Roslyn, N. Y., for use on lighter bombers.**

• **New Display Panel—RCA reports two new types of image-display devices which bear some resemblance to units previously reported by Spitznagel and DeMott. One, consisting of a sandwich formed by thin layer of cadmium selenide (photoconductive) material and a layer of electroconductive material separated by thin layer of opaque material with a voltage applied across the sandwich. When a heat image strikes the cadmium selenide for a short as 1-100 second exposure it becomes conductive and causes electroconductive**

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Look at this new flight-test oscillograph—

CEC's new 5-122 operates in a temperature range of -65°F to $+250^{\circ}\text{F}$ at altitudes to 120,000 feet. Twenty-six channels (plus two static reference traces) can be recorded. The 5-122 also meets the challenge of resistance to vibration, shock, corrosion, and moisture. It consists of three small, separate modules—oscillograph and magnetic tape, master timing unit, and control unit. Both the control and master timing units can be installed in remote locations.

Other features include new jump-boost selection method, flash timing, and improved automatic record identification system, explosion proofing in accordance with military specifications, crash-resistant magazine, and provision for synchronizing the 5-122 with an external data-acquisition system. Compact size is 11" wide by 6" high by 18½" long.

Weight is 10 lbs. fully loaded, 55 lbs. without magazine. Power requirements: 200 volts, 400 cycle, 3 phase. Contact your nearby CEC field office, or write for Bulletin CEC 1585-36.

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stress, fatigue, and corrosion in the aircraft industry include:

• **Troxon Inc.** has purchased **Aerovision Products Corp.**, Whittier, Calif., maker of pneumatic and hydraulic control devices for aircraft and missiles. New acquisitions will continue to be headed by Robert G. Rogers as president.

• **Chicago Aerial Industries, Inc.** has opened new Western Regional office in Los Angeles, headed by Charles Z. Bodet.

• **Sperdy Rand** is stepping up plans for expanding its **Sperdy Turbo Engineering Laboratories, Salt Lake City**, where company will build Segment model-New 100,000 sq ft addition is nearing completion and company plans to add another 100,000 sq ft and convert expansion originally scheduled for 1979.

• **Tuber Instrument Corp.**, North Tonawanda, N. Y., has opened new **Electronics Division** to produce precision transducers and transducer amplifiers.

• **E. & Young Spring & Wire Corp.**, Detroit, has purchased the **Link Rods Corp.**, New York City. Link Rods is active in engineering operations which produces AM and PM module radio equipment will be moved to parent company's Grand Division in Barlett, Calif., which also produces communication equipment.

• **Hawell Instrument Co., Inc.**, Ft. Worth, Texas, has opened a branch office in **Hato Rey, Puerto Rico**, which will manufacture, produce, and test subminiature and sub-miniature electronic test equipment. New plant is expected to reach full production by January and employ about 50 people. **John Papp** is general manager of new plant.

• **Strat Engineering, Inc.**, Pinfield, N. J., will shortly move its manufacturing operations to new 65,000 sq. ft. building adjacent to company's administrative-engineering building. New addition brings total plant area to 150,000 sq. ft.

• **Maxim Electrical Instrument Co.** has completed 25,000 sq. ft. addition to its plant at **Greenville, N. H.**—50% increase in plant floorpace.

• **Thiele, Raymond & Brown, Inc.**, State College, Pa., will build new facility about a mile distant from building now nearing completion. When new facility is completed next summer, firm will have approximately 71,000 sq. ft. of floorpace.



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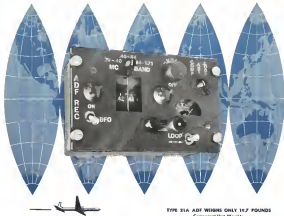


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The ARC Type 21A ADF is built to today's more critical speed and environmental demands. It has heretofore making of vital components, such as the entire loop assembly. It covers all frequencies from 190 kc to 1750 kc — operates on only 2.5 amps at 27.5 volts dc input or equal power at 15.5 volts. A significant feature is the extremely low loop design—only two inches outside the aircraft skin.

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in light T54 enclosures, 5 mc crystals are available with pigtail leads in 9 pin BNC type base. Resistor-Holmstrom Division of Dynamics Corp. of America, Glendale, Pa.

• Vacuum ionization tube, Type GIC-005, indicates ultra-low pressures at the 10^{-10} torr Hg region, processes sensitivity of 100 microns per micron. Output is linear through range of 5 to 10^{-10} to 10^{-9} torr. Hg. Collector voltage is ± 25 volts, with grid operated from 150 to 240 volts. Tube envelope is 7 in. long by 1 in. in diameter. Write for Bulletin No. 19410. Resistor-Holmstrom Division of Dynamics Corp., 1775 Mc. Road Blvd., Rochester 5, N. Y.

• Thermistor potentiometer, Type 10-M14, will dissipate 1 watt at an ambient temperature of 110°C, derived at 240°C. Wide voltage input is furnished in 4 in. long, 1 in. diameter stainless steel case.



Unit can withstand 1,500 volt rms dielectric breakdown test at room temperature. Murch Instrument Corp., 7924 S. Exchange Ave., Chicago 47, Ill.



• Precision pickup, Type 4-886, is designed for absolute and differential pressure measurements of non-corrosive fluids in ranges up to 100 psi. High level d.c. output eliminates need for signal amplifier. Operating temperature range is -55°F to $+250^{\circ}\text{F}$. Weight is 5 oz., height is 1 1/2 in. Murrer Forge is 21 in. space. General Dynamics Electrodynamic Corp., 160 Berry Motor Villa, Pasadena, Calif.

• Thermocouple reference junction, with 8, 12 or 24 channels, has temperature stability of $\pm 0.01^{\circ}\text{C}$ over environmental range of MIL-E-5172A. Uses air power to order of temperature loc-



tures 100 F and 500 F and can be used for one with any type in combination of Thermocouples Cathodic Instrument Corp., 4911 Redwood Ave., Los Angeles 46, Calif.



• Ceramic-pickled film resistors, called Filustron, meet requirements of MIL-R-101008. Tubes 482E, 495E, and 404K are used at 1, 4 and 2 watts respectively. Filustron has heretofore only used design reserve cases with removal to metal solder leads. Ceramic case is both water and vapor resistant and permits direct mounting in contact with conducting surfaces. Performance characteristics are given in Engineering Bulletin No. 7910. Sprague Electric Co., Marshall St., North Adams Mass.

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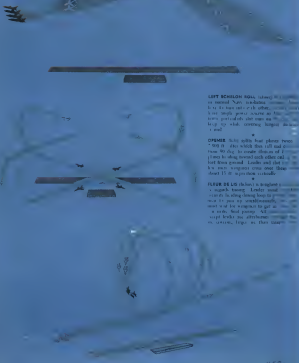
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LEFT SQUADRON Again, (above) 80 ft. apart, or more. Navy tradition demands that it is to be one or the other, never in-between. Single-point course as the formation moves, particularly the eyes on the leader, keep us whole, covering largest distance I could.

OFFENSE Eight eight-foot planes, seven 700 ft. in, the whole formation, from 80 ft. to make them of 1,000 ft. planes to show them each other and, in fact, the ground. Leader and the first wingman wingman come out there, about 15 ft. separation, usually.

FLYER DE LG (above) is angled a quarter of a square, being. Leader must maintain it along during loop to prevent, one, two to put up, unbalanced, the second will be wingman to get in, the third, last plane. All wingmen, except leader, are airbroom, wingman, in, extreme, legs, in, then, again, in.

Blue Angels Do Serious Job for Navy

By Edwin J. Reiben

Panama, Fla.—Two years and within minutes under the spotlights and sound of the Blue Angels flight demonstration team and explain outward-looking from high-ranking officials for more than a decade, including last budget year.

Blue Angels are high as an effective Navy service and public relations use, their personal appearances before mass audiences at naval air stations, including the epitome of best pilot flying skill in the latest combat-type equipment.

Three members of this novel service organization are to:

• Exchange precision flying habits in tactical and military affairs and develop inter-service pride in fielding an acoustic team competitive with U.S. and foreign military units.

• Channel untrained youngsters' attention toward naval aviation in a career.

To meet these responsibilities, the Blue Angels have evolved a 22-man, active-pilot, team known as being precise, combining, making for 10 low service pilots and 12 naval public. Manoeuvres, stable, standard acrobatics taught Navy pilots, tightened up to a hardening device and brought down to several hundred feet altitude to show what can be done with precision.

For crowd appeal there are three other of colored smoke and water and the boom of airbrooms being cut in on the team's new Grumman F11B Tiger.

Tight Formation

The Blue Angels strive to fly the tightest formation in the business, normal vertical separation is about 100 ft., but with about half of the wingman's main wings overlapping those of the leader's.

In demand, the distance is varied down to six or eight feet from the leader's tail.

If there's turbulence, the formation spreads out a foot or so, depending on conditions.

Flying this tightly, the Angels meet an aerodynamic phenomenon called porcupine effect, a cushion of air flowing ahead and around the surfaces of their planes. This pressure effect maintains outward 20 ft. track to push adjacent parts of the nearest airplane away. In demand, Cmdr. Edward B. Holley, the leader, feels the effect the most, both wingmen tend to push his airplane up and the last plane cuts an upward position on his tail. Effect is so strong that the three other wing-



GROUND CREW prepares to start a Blue Angel Grumman F11B Tiger for a practice loop, practice checks and starting, control is handled with 40-ft. team precision of an actual air show by leaders who provide team to show as a Douglas B-1D transport fitted with drop fuel schedule of about, daily practice loop gives pilots and ground crew little time off of job.



COMPRESSION given as start in Tiger Wright J5 W-11 subject. Airbroom are standard under. Riders with only given desired to provide bigger cover for work involved. When team gets new planes, color, smoke are used over to Navy's Training Command.



TEAM LEADER Cmdr. Ed Holley (left) checks a point on a maneuvers with team Lt. "No problem" among pilot eye language. Cmdr. Holley joined Blue Angels in Aug. 1995, Lt. Fennel, leaving team for a career assignment, joined the team in Oct. 1954.



RIGHT SCHEDULING is practiced high in the sky over Pensacola, Blue Angels start their maneuvers at about 300 ft. below an audience.

ben of the team could easily roll the leader's airplane if he were to let them.

Airplanes can be stable naturally trimmed, but as soon as they pass proximity effect, they tend to put their wings out of trim. So pilots each have to deal in proper trim to counter proximity effect. This is not acrobatic as people as it sounds because there is no trim rolling against there proximity effect is not constant. Angels say it is much less predictable as the Tiger than on their earlier F-8 Crusader and airplanes tend to pop in and out of position. Also, as the airplanes change position in the course of the maneuvers, proximity effect varies up and down the chingero and the Tiger has to be trimmed accordingly.

The trick is not to trust that the airplanes move into their new place to put in the necessary trim, but to develop knowledge of the maneuver so that pilot is building in approximately two he knows he will need while his plane is getting there.

Positive Trim

Necessary at all times is some positive pull this on the stick, perhaps a quarter G, to overcome possibility of developing pilot induced oscillation in the airplane body.

From the ground, the four airplanes seem to swing through their maneuvers as smoothly that it appears that they are tied together, actually a close knit would seem from becoming as the pilots fight turbulence, proximity effect and speed to keep their airplanes evenly spaced. Wingtip vortices are coming up and down and dispersing, which

Guarantees jets are in place of conventional maneuvers, are constantly popping in and out of each wing. This is strictly a stick and throttle operation. Sort of the down to bring the pilot's hands up high to provide a foundation on which to rest the right foot. The effect is held tightly against his seat for improved leverage. Stick is constantly moving around in an arc of less than six inches. Stick arm gets a good workout and much of the Blue Angels develops a right hand arm, noticeably heavier and more rounded than the left.

A pilot must not let a Blue Angel (usually Libman) pick off high loiter flight gloves after a practice session here. Not yet onto the trick of putting in trim to hold his wing against the proximity effect of the airplane flying with him, he had been fighting to hold the airplane merely with the stick. The right hand, motion nearly twice normal size, situated in the physical punishment it had taken.

There is almost no wearing of gages, the 22-man show goes on with the pilot's eyes glued to the leader and other airplanes. They are into and the acute sense of timing and display developed through unassisted practice hours. Talk to the Angels and they have only a half-pink grin as to their speed and the Gs they are pulling.

Team doesn't smell. Guilt. Maximum force pulled during any of the maneuvers is about 6 Gs in the final de la and that as badly it doesn't bother the pilots. At other times they go to 11-4 Gs, but again only for a instant. Speeds are held well below the com-

mon of the F111-F's supersonic capabilities, this will range from a high of approximately 600 mph in the high-speed low altitude speed during which the planes come from four different points to 300-400 mph in most of the maneuvers.

Two Shows

Angels have two shows in their repertoire: the complete traditional evening 20 maneuvers including solos if coming in at least 10,000 ft. and visibility five miles and a "flat show" if the ceiling goes down to 5,000 ft. and visibility to three miles. Later, understandably, delicate vertical maneuvers, such as loops, apices and floor de la.

Generally, the team flies from its home base at Pensacola Field, Pensacola to the show site two days before, the show opens. Early arrival not only gives pilots a chance to practice and to pick maneuvers, but also they will use in timing their maneuvers, but is also designed to give the team maximum public exposure in personal appearance, handouts and interviews and press sessions.

Totally, usually down to 5,000 ft. maneuvers, are a huge formation, with wingtip clearance. Cmdr. Hollis flies ship Number 1, Lt. Robert L. Rasmussen in Number 2, Lt. Sheldon G. Schwartz in Number 3 and stepped off his wing, still miss Lt. Nello Perena flies Number 4. Solo, Lt. Thomas K. Jefferson in ship Number 5 and Lt. Herbert P. Hunter in Number 6, take off separately.

After the airplane group leaves up

on the runway, Cmdr. Hollis gives turn-up signal by hand, goes up to 100 ft. per second, then, brings the power back to 97% and holds the throttle. When Hollis drops his hand, he takes his feet off the pedals and the four planes start to roll together. Next signal is by quarter movement "Barrel roll" Now, he applies 97% afterburner power. Remainder of the quarter does likewise.

In losing a margin of power, leader gives loss of air in constant motion to play with so that they can move off negative maneuvers, should he move out ahead of the group they would have no way to stay with him.

As soon as the Angels which lead the ground, detour Lt. Perena is taking his airplane over behind Cmdr. Hollis using rudder cable sometimes, rotating his gear. At the end of the run, the turn is a tight diamond formation which it builds for about three miles. Landing is by watching his reference points on each other's airplanes. Weapons, for example, right along the leader's wing leading edges, line up the center of those fuselage devices, pointing from his wings with the tip of his fuselage and must roll just the canopy, hoop onto the leader's flag (tailfin) or corner hook.

For their corner the Navy jet quarter comes over the spectators at 5,000 ft. at 520 mph, indicated, arrived in trail formation, nose to tail. At a predetermined point in front of the spectators (usually) a turn, Cmdr. Hollis gives the maneuver cue. Heads back, which yields the nose into its arc, around, Cmdr. Hollis and Lt. Rasmussen.



ON THEIR BACKS over the water, trailing colored water from nitrogen. Blue Angels also create equally tight diamond formation all the perform at 500 ft. altitude at times.



BLUE ANGELS FLIGHT DEMONSTRATION TEAM (1) to (4) Lt. Cmdr. William Chase, maneuver officer; Lt. Sheldon "Lefty" Schwartz, left wing; Lt. Nello Perena, left; Lt. Thomas Jefferson, left; Lt. Cmdr. Edward Hollis, leader; Lt. Robert L. Rasmussen, right wing; Lt. Herbert Hunter, solo and Lt. Mark Poyard, public relations officer and pilot of second F-4B.



Bill Remmert brought R-W service to Pompano. Below him, a DC-3 covered in many conversions.



Bob Werner took over of his time at Remmert-Werner's home-base operation in St. Louis.

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that's Remmert-Werner's 10-year record!*

In June '56, a caravan of three giant mobile units left Remmert-Werner's home base, Lambert-St. Louis Municipal Airport. It was headed for Pompano, Florida.

Bill Remmert took the caravan. Utilizing its complete machine, woodworking, and electrical shops plus radio racks, stockroom and expert mechanics, he established another R-W staffed base.

"When we took over the Pompano field," recalls Bill, "we needed fueling equipment—fast. Shell engineers came down and designed our bulk plant. And almost before we knew it, there were the three 15,000-gallon storage tanks we ordered waiting out there on floats, ready to go. Shell helped us zoom into business."

Besides servicing a good number of America's 38,000 corporate planes, Remmert-Werner also converts surplus commercial and military aircraft into luxury planes for private owners and corporations.

In an ordinary conversion job, R-W rigs out every bit of wiring and piping, and installs completely new systems to customer specification. Lounge chairs and sofas, tables, lamps, galleys and any other special furnishings are designed and built by R-W craftsmen.

Among the organizations that happily fly Remmert-Werner conversions are Olin Mathieson Chemical, Grumman Aircraft, Hercules Powder and Owens-Illinois Glass.

"It didn't take long for us to find out that when you're a Shell Dealer, business flows your way," says Bill. "Shell works right along with you, helping you build your business. They've even helped us locate old DC-3's when they've been hard to

get. A Shell man spotted some whale traveling in Turkey last year. We went right over there and bought them. Most of those '3's have already been converted into flying yachts."

If their first 16 months of Pompano is any indication, Bill Remmert and Bob Werner are on their way to making R-W service available to America's ever-increasing fleet of corporate aircraft.



Below: C. B. Weeks (right), R-W sales manager, and client discuss plans for a Grumman "Geon."



Above: R-W conversion facility a converted "Geon" with Shell Aviation Gasolene.



Below: R-W workshop. Remmert works on DC-3. They'll install new wiring, insulation, picture windows, and furnishings to order.



Above: Betty Remmert (right) shows prospective client through completed interior. R-W conversions will for as much as \$300,000.

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new

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CONVIAIR 688 HUSLER the U.S.A.'s first modular bomber has a new and important application for rotary latches

HARTWELL Type H102 Rotary Latches (2) are used for locking each variable afterburner to each engine in the reactor

ROTARY LATCH FEATURES

ULTIMATE LOAD 7,000 lbs (CONVIAIR 688 lbs)

TOTAL UNIT WEIGHT 30 lbs

ADJUSTABILITY A 90° adjustment of 30° is provided in an axial direction normal to the locking direction, and is accomplished in half turn movements (50%) of self-indicating the locked position

OPERATION Operated by a standard under screw handle 24 inches from the rotor axis, disengages the key after 135° rotation. Axial take up in both run is required from open to closed position is 30° - 40 closing parts are self-lubricated.

INSTALLATION Fits in structures are chemically-treated. All holes and cutouts in components or shell cut to allow for simple installation

SAFETY Positive locking is provided in failed position by preventing under screw rotation. A visual indicator displays the locked or unlocked condition

WIND LOAD CHARACTERISTICS The weight versus ultimate strength curve in tension is higher than 177,000. Excellent fatigue endurance. Eye bolt shank serves as a shear pin bracket and rig structure.

OTHER ROTARY LATCHES ARE AVAILABLE TO MEET SPECIFIC DESIGN REQUIREMENTS SUCH AS: (1) one-piece, (2) one-piece provided where rotation hazards exist; (3) several configurations available to meet various load requirements, (4) fuel and/or liquid gas control applications are provided. Weather availability is optional

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men's heading. Lt. Mark Schwartz and Lt. Permon, leading right. Forty seconds later, Holly calls the second break, each pair splits again and the team is diving apart at 90 deg. from each other. Almost instantly comes the cue, "Break Ball" and the F-111s roll over and are heading downwards at leaving white smoke from the tubes alongside the port side of the fuselage (according to these budgets) to provide guidance with optimum visual impact in this, come facing each other the field towards each other at a closing speed of 3,750 ft/sec.

Converger Technique

Each team is watching the others on the ball, curve downward, tracing paths by smoke trails piping closing rates and adjusting power to attempt to make the converger appear stationary. If the airplanes are going to cross the runway at right angles, the two low drops, Cade Holly and Lt. Permon, coming across the field about 10 ft off the ground are separated horizontally by the width of the runway. At turning is right, Lt. Rosarino and Lt. Schwartz will pass over them at right angles with about 15 ft separation. Separations are marked out by eye, set by the guys. According to the Angels they would make this an easy exercise to calculate.

While Cade Holly is banking around 90 deg. pulling up a steep climb to left speed and raising off his winged to guide the others in the pass-up Jefferson and Hunter in the solo. Vigns cross during at about 575 mph, along each side of the runway for separation. They cross in front of the groundradar, at about 100 ft altitude. Then on the signal, "Roll," they make three vertical rolls to the left, which, if they verticals, will take them to about 32,000 ft.

Purpose of the rolls between each maneuver, or at the quarter is to divert the crowd from the line Vigns that are returning for the next maneuver, thus keeping the air filled with action.

Lt. Jefferson, one of the soloists, which are so timed that when he gives the signal, Lt. Hunter knows that they know. Her first will pass over the center of the field 70 seconds later. Solos come down from altitude. Lt. Jefferson from about 4,900 ft. and Lt. Hunter from between 4,000-7,000 ft. because he has worked out his timing from the higher altitude. Solos use the same four positions in all of their passes, make their rolls to the left. On the knife edge passes they go in corks, to corks. On rolls and the knife edge the aircraft need to lose altitude, requiring the pilot to get the nose up, making this airplane climb in the reversal. Be the top of the arc they are looking at full radar.

Throughout the solo maneuvers to di-

How Blue Angels Plan Show

How Navy plans a Blue Angels flight demonstration team show at one of its air stations to get maximum community and public relations coverage is detailed in this typical schedule which budgets every available hour that the team is not being This was a recent appearance at Spokane, Wash.

SEPT 20

- 1300 Induction: Right for local press by Lt. Mark Permon, Blue Angels' public information officer in Gannett PW-11 Cougar (two-man).
- 1400 Team appears on Rod Clifton's "The Winner" show, radio KHQ-TV.
- 1410 Blue Angels appear on local radio's "On the Air" show, station KHQ-TV. Angels make evening cut to show's Hospital for crippled children.

SEPT 27

- 0900 Practice pass flights by F-4s in F-4E's.
- 1200 Blue Angels (three) at breakfast with armed services committee of Spokane Chamber of Commerce (both team members make a three-minute speech).
- 1300 Additional press flights in F-4E's.
- 1400 Team arrives at station KHQ-TV for interview with "Data With an Angel" (Angels in contact conducted by station).
- 1500 Appearance at station KHQ-TV for appearance on Dick Jones show.
- 1600 Arrival of Downtown Hotel rooming good lounge for members and attendants with "Data With an Angel" (Angels).
- 1800 Five time to prepare for evening program.
- 2000 Meet the five "Miss Naval Air Station" queen Angels at Roberts Hotel for dinner on hotel and garden.
- 2200 Transportation arrives to take guests Angels home.

SEPT 28

- 0800 Flights in F-4E's for news media.
- 0900 Briefing on Civil Aeronautics Administration Regulations regarding air exhibition.
- 0930 Blue Angels put on practice show for local television.
- 1200 Depart for Pullman, Wash., with five guest Angels to watch Washington State College vs. University of California football game.
- 1400 Arrival at station, Western of "Data With an Angel" and Miss Naval Air Station contacts are announced over public address system during ball game.
- 1500 Blue Angels and women to appear on station KNEW during ball team news corner.
- 1600 Leave Pullman for arrival in Spokane.
- 1810 Arrival at Spokane, four hours for Blue Angels, Miss Naval Air Station and her court takes home to breakfast.
- 2000 Girls are taken to air station officers club where they are guests of Spokane Chapter of Navy League for dinner.
- 2050 Transportation arrives to take girls home.

SEPT 29

- 0800 Complete media flights in F-4E's.
- 1000 Blue Angels team leads in strict criteria with Navy League "boulder" (8 ft x 4 ft).
- 1515 Station commanding officer Capt. Furell (Hill) welcomes aboard team and distinguished visitors, introduces Miss Naval Air Station and the major and committee of the queen coronation on stage.
- 1400 Blue Angels take off for formal air show for spectators.
- 1500 Blue Angels start flight demonstration.
- 1710 Team can leave and turn in the five.
- 1800 Blue Angels arrive at officers club to meet invited guests.

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to flag section with Adam Rarick on the West Coast.

Candidates for the Blue Angels are seasoned fleet pilots, holding down a stretch's shift with Lightning Command and also volunteers for arduous duty. Ten candidates are to be selected out of the team to fill two openings. It takes approximately six weeks to bring a new team into the division and three months of tough practice before the team is polished to its extreme and ready for the road.

Forty-five selected men headed by Lt. Cmdr. William P. Olson, senior lance officer flight maintenance, with Chief Thomas Keller as maintenance chief. Cross are hand-picked. Since there are more applications than spots to fill, Chief Olson goes through candidates a thorough screening and takes those with best records in sea theater and surface, providing they can put in a minimum of two years with the corps.

Hard Work

Chief Olson lays out the hard facts of working on the team to candidates long before they work out of work. Looking ships in shore for shore and considerable amount of traveling. Later is especially hard on the limited man. Because they travel in a group (about 21 men, Chief Keller, and Chief Olson) spend much time in a RQ (dread with work, hotel), they don't get per diem and usually wind up spending more money than they would on normal shore duty. Work schedule is so tight that during show season, most of the holidays in time, more they are generally show days for the team. Also, it is not uncommon for crew to work until midnight for day getting ships ready for a show and then have to fly cross-country for a holiday celebration.

Spillout on Crew

To train the team by, visited get the line service of its airplane so that all of the ground crew gets out in front of the road.

Divided in special units, then go through the routine of discharging the airplane, fighting them with drill team personnel.

To expedite acquisition of needed parts, the surface and engine man. Factors have representatives assigned to the Blue Angels on a full-time basis. Dave Scherer of Grumman and Tom Larson of Convair Wright. For example, if an aircraft is out of commission for need of a part and part is not available in the Navy's supply system, Scherer can call directly on the Philadelphia Aviation Supply Office, get a dispatch number for the needed part, which he then gives to Grumman, which in turn arranges for the part.



Iroquois Installed in Testbed

General Motors Iroquois engine is almost ready for its first flight testing in the Boeing B-47 supersonic bomber. After installation by Convair Ltd., in Montreal the aircraft was delivered to Canada at Malton, Ontario. During ground testing the engine were in suffered by the large and (top). First view of the experimental engine installation is shown below from inside the aircraft. Design of the engine support pylon was particularly troublesome.



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X-18 MODEL in horizontal flight, ready to slow down for transition to vertical flight as low speed tested at Langley Field.

Hiller X-18 Model Free Flight Tested

Hiller X-18 VTOL design has successfully passed free flight model evaluation of the National Advisory Committee for Aeronautics Laboratory at Langley Field, Va.

A six-foot wingless model of the flying, naturally VTOL, was released. Flown in NACA's large low-speed wind tunnel which has been used for other NACA studies of STOL and VTOL aircraft.

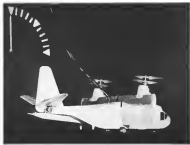
The model incorporated full provision for remote control of all aerodynamic surfaces, wing tilt, propeller pitch and power changes of its electrical motor drive, Hiller said. Each flight in the free flight program simulated a normal and complete transition sequence. Hovering and transition were continuously performed with ease, Hiller said.

Stability and control were tested over a wide range of speeds, power settings, time and extreme center of gravity locations. Conditions during takeoff, landing and sustained hovering in and out of ground effect were also explored. Hiller said that the results were interpreted as further encouragement that a propeller-driven flying configuration is practical.

Next phase of the X-18 program will be the flight test of the full-scale aircraft which is now in advanced stages of construction at Hiller's Palo Alto, Calif., plant. The X-18 has been built around a Chase transport hull to which has been added a new flying wing carrying two Allison X-310-14P XT-18-A-14 turboprops having counterrotating propellers. Jet engines providing thrust to provide control moments during VTOL flight.



X-18 HALFWAY between horizontal and vertical flight. Fuselage behind model indicates thrust unaltered has decreased. Power and control come through cables.



NOW IN VERTICAL MODE, X-18 is ready to slow down for VTOL landing. Stagger-like propeller from underside of tail is the jet which supplies control during VTOL.

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The Type 3006 Coaxial Collinear Antenna*, consisting of three half-wave vertical dipoles arranged collinearly and operating on a frequency range of 150-176 MC, is especially suitable for patrol car broadcasting. The three vertically arranged dipoles exhibit a gain of 5 to 6 db over a standard single dipole, and produce a low angle of radiation with equal radiation in all directions.

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MISSILE ENGINEERING

Laboratory Studies Missile Reliability

By Richard Sweeney

El Cajon, Calif.—Operational regime needs of today's missile vehicles and weapon systems have drastically changed conceptions of reliability standards.

What once was the concern of a few engineers and inspectors has become an integral part of top management planning and a responsibility of management from top to bottom, according to Dr. Leslie Ball, technical director of Shellfish Laboratory, Inc., and a consultant on reliability in aerospace and missile components.

Regarding a new philosophy on reliability, Dr. Ball says:

- Age part, component or system, is relatively unimportant until every mode of failure is known, understood, measured and controlled.
- No longer will functional tests and conformance to specifications be adequate. These, along with traditional quality control methods and a substantial basis for selecting test articles, are not sufficient for today's and future complex weapon systems.
- Early and random failures are the dominant cause of unreliability in today's highly complex systems.
- Reliability upgrading must be obtained by a direct loop of detection, analysis and corrective processes.

Close Failures

Dr. Ball's thesis is that basically, unreliability results from those failures which occur once in perhaps 10,000 trials, and are subtle modes of failure not described in basic models, which occur would be thought of as planned defects, fabrication and testing procedures.

In addition, articles comprising today's complex systems are not linear homogeneous production populations. Dr. Ball says, for if they were, failure rate and cause causes would all start at similar stress points. Also, there are in many failed parts that conventional quality control and functional tests are inadequate, he believes.

To overcome this, he calls for production environmental testing of each component and system to the point where the good pieces are not damaged but those with potential early and common failures are weeded out.

Based on Dr. Ball's philosophy a compilation of reports which would create a bank of integrated knowledge on failure in all parts, components and



HYDRO-PNEUMATIC test system at Shellfish Laboratory includes two concrete test cells (foreground), various test articles that simulate pressure changes inside weapons in flight. Right: test tank contains missile, left test tank is water reservoir. In operation water fills the inside tank in the same way that liquid oxygen and fuel fill a missile.

systems with which a contractor is concerned. This bank would furnish information to designers and quality control personnel who are conducting on new designs, and would be of such a nature that reports on the company's reliability position could be added at any time for presentation to top management in the same manner that so-called complete and prompt financial data to indicate the company's fiscal position.

Nationwide Reliability

Carried further, pooling of failure mode knowledge on an industry-wide basis rather than considering each contractor a proprietary matter would yield information which would be available

to all involved in weapon system work, to produce a national, across-the-board reliability upgrading which, Dr. Ball believes, would be to the ultimate good for all concerned.

Indicative of the status of reliability today, Dr. Ball points out that one major contractor has, on an ongoing basis, 10,000 of its employees working on reliability of equipment, one third in design and manufacturing.

Approximately 30% of the total expenditure on a weapon program today, according to Dr. Ball, are involved in reliability.

Reliability substantiation and upgrading must be built into any program from conception, Dr. Ball indicates. From contractor and customer alike

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data signifying a contract will have to see that tight reliability programs are needed. And management should work out a series of contractually binding milestones to be placed at stages along the design and manufacturing so precise that errors of accountability are decreased to specific numbers and test steps.

Detailed Vendor Data

Subcontractors and vendors must be required to furnish comprehensive reliability data in great detail for each quality unit in the development program. Scope of these data should encompass:

- What tests are to be performed?
- Where they will be accomplished—at the contractor's plant and under whose supervision—or at an outside laboratory facility?
- Who will make decisions concerning quality of tests and results, that is, will the decision power be completely that of the contractor concerning the part under investigation?
- Exactly what equipment will be used in tests, what capabilities does it have, is it tested to substantiate the quality and accuracy of data yielded by tests as completed with the equipment?
- Reporting procedures which clearly indicate the closed loop of failure detection, analysis and recurrence procedures.

Execution of all modes of failure, Dr. Bell declares, is dependent on two things. First, independent evaluation outside the company making the part and second, complete desk analysis along with testing of the part.

Choosing out the theme of an important laboratory capable of conducting tests under the same reliability one could located in establishment of Stollendrup Laboratories, Inc., on a 13-acre tract in College Park, Md.

To clarify keep the facility free of personnel involvement, Stollendrup support is provided by an Eastern group whose associations center in hotels, hotels and other service-related fields.

Currently, about 5,000,000 is invested in land and facilities.

Reliability Discipline

Stollendrup is expected to provide complete reliability discipline for all segments of the aircraft engine industry, under the Bell philosophy, is chasing establishment of reliability in government, testing and reporting on reliability portion.

The laboratory now has in operation an installation capable of production environmental testing of airframe structural ballistics missile hydro-pneumatic systems and components under simulated flight conditions and circumstances. The firm is devoted to this activity.

Work is under way as \$70,000 addi-



INSTRUMENTATION and control room (above) at Stollendrup shows pressure gauges, recording oscillographs, etc., that measure and monitor performance of system and test units.



INTERIOR view (above) of stainless steel explosion proof test cell shows electric heat exchanger that insulates inside temperature variations. Test unit below is on center.



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Synthetic Resins • Chemical Colors • Industrial Adhesives • Phenolic • Polyurethanes • Epoxies • Plastics • Polyesters
Metric Adhesives • Solvent Aids • Solvent Solids • Polyurethane • Polyurethane • Solvent Aids

tion which will yield capability in cold flow work. Located recently on another floor-level section of the tract, the facility will incorporate its own special test cells with provisions for the benefits inherent in working with liquid oxygen. This unit will be tied in with the hydro-pneumatic section, giving added capability for certain types of test work. The cold liquids unit is expected to be in operation about the first of the year.

Another five-acre section will be the site of electronic test facilities and adjacent buildings. Some electronic testing already is in progress, and present test facilities include smaller standard environmental chambers and related equipment.

Flight Conditions Simulated

To provide reliability data under valid conditions, Reichhold's facilities are geared to simulate flight conditions with the accent on their highly transient nature. Wide and rapid changes in temperature, pressure and stresses are reflected in the laboratory's facilities, and complete accent is taken of both magnitude of variation and the time involved.

The hydro-pneumatic facility includes tanks, ducts, control valves and bellows—pneumatics sources which simulate the fuel and oxygen systems of existing missiles. In addition, provisions for static cold work are in operation, using nitrogen as liquid nitrogen. When the cold liquids unit is in operation, tests will be simulated in cold.

The presently operating facilities include three tanks: a vacuum tank for simulating the rapid changes of pressure as a missile ascends, a tank simulating the ramjet tank and a water vapor tank. In operation, water fills the ramjet tank as liquid oxygen and fuel fill the ramjet. In a blowdown, the liquid forces liquid from the ramjet tank into the water vapor tank, and provisions are made for recovery and reuse of water and helium.

Vibration, Moist Tests

Also in operation is vibration, acceleration and heat exchanger equipment capable of simulating conditions as the missile takes off and accelerates through aerodynamic heating into the tail at very high velocities reached in flight. Facility provides for flow of helium through the test article while vibration and acceleration are in effect.

The cold flow facility begins with the hydro-pneumatic system as set for added versatility alone. To provide cold liquid flows as they occur in ramjets, helium pressure will be used, circulating mechanical pumps and their associated for lubricity, a line heated with liquid oxygen. To resist chills,

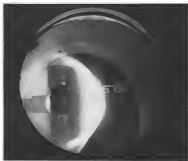
liquid nitrogen will be used as cold liquid flow facility for easier handling and removal cost, will later be supplemented by liquid oxygen.

Cold flow unit will use tanks consisting of stainless steel light gage liners in a concrete shell, less expensive than conventional large tanks for liquid gases. The pressurizing gas will be ducted underground from the hydro-pneumatic test area in the cold liquid area. These tanks will be used two for programmed flows, one for steady state conditions.

USAF Interested In Turbo-Rocket System

An turbo-rocket propulsion system now under private support by Aerojet General Corp., Azusa, Calif., is being formally tested upon its USAF, a paraffin-based rocket launchers with advanced programs told Avionics Week.

Aerojet, which has joined with Allison Div. of General Motors to obtain the advantage of that firm's large air-breathing development facilities at In-



Nose Cone Model Glows

Now one model and its surrounding air are heated to temperatures during test as the heated tunnel at the USAF's Arnold Engineering Development Center, Tullahoma, Tenn. Much smaller of the air was about 35 and stagnation temperature approximately 30,000°F. The tunnel has international flow and is driven by an electric arc. Test can last about 100 ft of a second. Men below are adjusting the tunnel. Most at left is looking into the test section, one at right is by the air.





MAXIMUM ELECTRIC SYSTEM COMPATIBILITY, providing greater safety and reliability, will result from selection of General Electric as a one-source supplier for the Convair

880 electric system. Weight of the complete 160 KVA system is approximately 270 lbs. Of this total only 830 lbs. are carried in the four engine accessory compartments.

Convair Simplifies 880 Component Integration by Selecting Complete General Electric 160 KVA System

By extending the complete system from prime mover to the bus from General Electric Convair will greatly simplify the integration of 880 electric system components. Throughout all stages of development and testing, problems involving such time and cost consuming factors as wiring readily resolved, efficient integration of the latest safety and reliability advances into a completely compatible electric system.

Even in the early design stage, advantages of the package electric system approach has great dividends in time and cost savings. For example, a complete design study was made involving the characteristics of engine acceleration, tachometer output, constant speed drive, generator and electrical system to eliminate proper engine starting time with a minimum of vibration effects.

Another example of co-ordinated development is the designing of the safety master paneling of the generator. In this instance, ready availability of constant-speed drive data allowed the design of paneling circuits in the electric system

which will minimize weight, in addition to simplifying the system—without creating excessive electrical disturbances. This and similar co-ordinated development tasks are accomplished within General Electric, prior to final recommendations to Convair.

In addition to the advantages of co-ordinated development, Convair's selection of General Electric aircraft electric system equipment simplifies integration of the latest component developments. Tailored to the specific requirements of the advanced airplane these proven techniques will contribute to:

GREATER SAFETY—Changing motor voltages to any phase of the equipment are prevented by application of the highest phase tolerance among principles in both the voltage regulator and over-voltage relay.

Another safety feature is the permanent magnet generator incorporated in each phase of the system's four statically excited generators. The generator fanbelts are tied points completely independent of the main power system. Also, since the per-

manent magnet generator is used as a source of initial building, the generator when de-energized has less than one volt residual to find a feeder fault.

Control relay, generator line, and bus-bar connections are all magnetically-held-type spring loaded to the "off" position. This guards against loss of protection due to loss of power. In addition to the completely automatic protective system, the pilot is provided with a manual shut off to de-energize the electric system under emergency conditions. Here again reliability is not dependent on any source of electric power.

Added safety devices to be built into the hydraulic constant-speed drive include a malfunction detector, speed detector, overvoltage and under-voltage, and an overvoltage clutch.

HIGHER RELIABILITY—Use of the statically excited generator simplifies cooling of the rotor and windings and replaces the rotating exciter with an inherently more reliable static exciter mounted in the aircraft wheel well. The permanent magnet generator provides initial build-

up, eliminating delays due to loss of residual magnetism.

Magnetic amplifier control circuits eliminate critical adjustments of sensitive relays, decreasing the probability of miswiring. Fully shielded hermetically sealed relays, independent of environment and contamination, will be used.

Simplicity of design, obtained by use of built-in parts, increases reliability of the



SWIFTEST PHASE TAKEOVER DESIGN—will be incorporated in the control panel for greater aircraft safety. The automatic protective system is independent of any power source.



2000 HP bearing and brush life is offered by specially selected generator for the 880 KVA.

model 160 generator and control life will be 2000 hrs—maintenance at 2000 hrs intervals.

General Electric hydraulic constant-speed drive. The design has a minimum of moving parts with the majority of the stress taken by the five major transmission parts. The unit housing serves only to align the working parts and provide support for the generator.

IMPROVED PERFORMANCE—Improved voltage control with static excitation produces better performance of load equipment, particularly sensitive electronic gear. Thus for return to normal voltage after application or removal of load is reduced as much as 40 per cent based on successive loads of the next machine with reflow and static excitation. System stability is sufficient and normal voltage is obtained with little or no overshoot or undershoot. Post build-up of current on application of loads reduces clearing time for load current breakers.

Measuring only 10 in. by 10 in. diameter, 21½ in. in length, and weighing just 132 lbs., the compact, lightweight combination of hydraulic constant-speed drive and statically excited generator was an obvious economy in space and reduces engine pad weight. This helps reduce aircraft nacelle weight and drag penalties.

For more information on General Electric aircraft electric systems, components and development capabilities, contact your General Electric Aviation and Defense Industries Sales Office or write to the descriptive brochures offered in the coupon below. General Electric Company, Schenectady 5, New York.



DOUBLY SIMPLE AND RELIABLE, built into the hydraulic constant speed drive for the Convair 880 has an input speed range of 5000 to 7700 rpm and an output speed of 5000 rpm.

Mail to:
Division A210-100
General Electric Company
100 West Road
Schenectady 5, N. Y.

☐ 88A-4018 Hydraulic Excited Aircraft Generator

☐ 88A-4074 Hydraulic Constant-Speed Drive

☐ 88A-4016 Static Exciter for Constant-Speed Drive Operation

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Test stand for running jet engine ball bearings at high speeds, high temperatures under heavily loaded conditions.

RESEARCH NEVER STOPS!

Tomorrow's needs are today's concern at the aircraft ball bearing research facilities at New Departure. For the future development of the ball bearing will be closely identified with future engine design trends. This means New Departure keeps no effort in developing bearings to operate at higher speeds, heavier loads, and under higher temperatures with good bearing-life predictability.

As always, New Departure keeps pace with changing conditions in the industry. For New Departure's design and fabrication processes for current high-speed, high-temperature, heavily loaded ball bearings are major factors in the successful operation of today's jet engines, as well as auxiliary turbines and accessories.

For aircraft and accessory bearings, send for CATALOG ABG.

For data on research progress for jet engine bearings, send for REPRINT JEB.



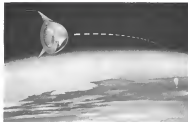
Instrumentation and control console for test stand shown above, for loading full-scale aircraft ball bearings.



NEW DEPARTURE

DIVISION OF GENERAL MOTORS, BRISTOL, CONN.

FORWARD 50000 0000 0000 0000



Satellite Recovery Proposal

One proposal for bringing a satellite back to earth was made by A. J. Egan of the NACA. He proposed a four-stage wind tunnel rocket and having within launch capacity of recovery was made at a small angle with the horizontal.

disaster, had, has been working on the hybrid concept for three years, especially with some USAF support. Aircraft has had a long record of success of the turbo-rocket running for two years.

The advantage of the turbo-rocket is that it combines the lower fuel consumption of an air-breathing engine with the high altitude ability of a rocket. Besides the hybrid advantage of sustained flight at very high altitudes (in the order of 100,000 ft.) a plane equipped with turbo-rocket propulsion would be able to fly at higher speeds (in the order of Mach 15) than those of a jet-fueled engine from one set of high altitudes.

The engine layout, which has been described in recent rocket textbooks, consists of a compressor driven by a turbine, as in a turbojet. But unlike a turbojet, the main airflow bypasses the turbine, which is driven instead by the exhaust from a series of rocket nozzles.

The turbine-driving nozzles are air-breathing and hot like rocket nozzles which burn fuels (about 3,000°F) to drive the turbine. Then the hot rocket exhaust gases are fired by the turbo-rocket to form a combustible mixture of the rocket, it produces an appreciable amount of carbon deposits.

A Pentagon source in USAF's advanced propulsion section refused to comment on the future of the Aerjet Alcon project except to say that the last knowledge there has been no lowering of funds despite the "lastest" Fourth of October.

Missile Firms Forced To Dismiss Engineers

Two firms which have recently been forced to dismiss rocket engineers talent, despite the apparent nationwide interest in rocket programs and continuing talk of the upcoming shuttle, are Bell Aircraft Corp., Dayton, Ohio, N.Y., and Aero Associates, Newark, N.J.

New engineers were reported from Bell's rocket engine department and 30 were given notice at Aero. "Members of both firms contacted by Aviation Week felt that there was more in the situation, especially as they feel these firms are on the verge of new contracts, expected after the first of the year."

Bell's brief was related to Russia missile contracts. Its hope for the future was tied to its advanced "new horizon" missile project. Aero related its situation to the reduction of the missile contracts which it serves and the drastic reduction in the number of study proposals concerning Iran, USAF and other branches of the service. Not only has the number of these small \$25,000-\$100,000 research contracts been cut down from the usual dozens or so to just during the last six months, but Aero now finds it is competing with many larger firms who would otherwise not touch this "little stuff."

Aero's hope lies in the present contract on solid propellant rockets. The firm, which has been reduced from 50 to a quarter 20 employees (and counting 25 left in its outside jobbing division).

Waugh AERIAL REFUELING FLOWMETER

Waugh model MF-1 is a 100-1000 gph flowmeter has been selected for the tanker version of the Douglas A3D Skywarrior to give precise measure, read and control of fuel transfer.



FEATURES:

- Simple, reliable indicator circuitry in flow sensor actuates quantity read signal light, no intermediate devices.
- Signal light to indicate transfer of fuel is activated directly from flow sensor.
- Slowly rotating turbine rotor is the only moving part—no relays or mechanical contacts.

Write for complete data: Bulletin 102-1000

Also available: Flow Rate Indicators and Recorder, Frequency-to-voltage Converter, Aircraft-purpose View Sensors.

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FLOW MEASUREMENT AND CONTROL
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Circle 5-100



THE SOLDIER

Much more than the H-Bomb is needed to insure our total security.

For the threat of massive retaliation is not a complete deterrent to aggression. Border incidents and "brush fire" wars cannot be handled by nuclear weapons alone.

What kind of military program, then, do we need? The consensus of top military strategists answers it this way:

We must have forces capable of meeting every aggressive threat, adaptable to the strength and skill of the aggressor and to the terrain, climate and geographical factors in the military problems involved.

This means the mobile, lightning-fast soldier of the new Pentomic Army...the man on foot with a gun in his hand, artillery behind him, and the full might of our entire arsenal ready for his support. For this man is the military policeman upon whom the keeping of the peace must always heavily depend.

Martin is a prime contractor to all branches of the military. Among the most advanced weapon systems currently being produced for the soldier is LAGRASSE. As the prototype of a new family of artillery guided missiles, this important weapon is one of the basic developments of the Army's advanced Pentomic concept.

MARTIN
BALTIMORE-DENVER-ORLANDO

and that it is now waiting for a certain prime contractor to get a go-ahead from the government.

Both firms emphasized that the programs which they were forced to let go were not "dead wood" but high grade engineering manpower. Some of the Bell men had born with the first four to seven years. It was a matter of "losing a man" to see who was next.

The discarded men are expected to have trouble in finding positions which would use their special talents unless they are willing to relocate. Both companies hope to be able to relocate them.

Services-Industry Meeting On Missile Training Devices

An inter-service and industry symposium on guided missile training equipment is scheduled for March 15-17 at the Naval Ordnance Laboratory, White Oak, Silver Spring, Md. To provide an opportunity for an exchange of information relating to this specialized field.

Symposium will review the state of the art of missile training device technology, philosophy, design, cost and utilization and discuss role of such equipment in measuring proficiency of units provided.

Sponsored by Guided Missiles Division of the Office of the Chief of Naval Operations, attendance will be limited to those with Secret clearance. Those desiring to attend may write: Mr. J. G. Vach, Head of the New Weapons and Systems Division, U. S. Naval Training Device Center, Port Washington, N. Y.

Driving Standardization Sought by U. S., British

Associate, British and Canadian delegates have presented recommendations for altering each country's defense position to that any engineering design product in one one of the countries can be easily used by factories in any of the other countries, according to Lt. Col. A. N. Henderson chairman for an overall standardization committee which met recently in Toronto, Canada.

This country will incorporate changes in the American Standards Association's Y14-1.6 document, Britain in the British Standard B. S. 308 document and Canada in the Canadian Standards Association's B75.1.

Standardization has been some 12 years in the works according to Vice Admiral G. F. Hume, Jr., of the American Standards Association. One reason such is that is the labor difficulties which U. S. licensors of British engines have had "Americanizing" British designs and, even more pertinent at this time, design difficulties which British missile firms might have adopting U. S. missile designs, will be eliminated.



Helium high pressure relief valve undergoing part of functional test procedure

An important feature of this assembly is its zero external leakage... while the maximum internal leakage is as low as 100 cc per minute at slightly below rated pressure. The unit is applicable to all types of helium and other pneumatic systems.

From Whittaker's Pneumatic Division:

High pressure relief valve for -320°F helium service

Here is another outstanding contribution by Whittaker's engineers in the field of missiles!

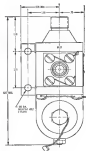
Specifications demanded a unit with a high degree of reliability and consistency... resistance to vibration and acceleration... and very short range between crack and reset pressures!

This lightweight valve—with all its basic components made entirely of stainless steel—meets all these critical requirements of a missile application.

In design and production particular emphasis was given to consistency, so that there is no variation in performance between one valve and another.

The tube size of this unit can be varied to suit customer requirements. Furthermore, the seat size does not increase in proportion to tube size.

This is only one of the many kinds of missile problems that Whittaker has solved. This wide experience is available to you now.



PERFORMANCE

SERVICE: Helium gas

FLOW: 6 pounds per min. at low temperature

TEMPERATURE:

Ambient, -120°F to $+100^{\circ}\text{F}$

Fluid, -320°F to $+300^{\circ}\text{F}$

PRESSURE: 3250 psi Operating Pressure

WEIGHT: 1.5 lbs

TUBE SIZE: $\frac{1}{2}$ "

SEND THIS COUPON FOR COMPLETE INFORMATION

Whittaker Controls
905 N. Green Ave., Los Angeles 38, Calif.

Gentlemen:

Please send me further information on the Whittaker

Helium Pressure Relief Valve, P/N 141595

Check one: ☐ Reference information ☐ Project information

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Company _____

Address _____

City _____

State _____

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Many are proud to work here at Continental Airlines' Club Coach DC-7Bs. They fly fast schedules between Chicago, Kansas City, Denver, and Los Angeles.



Says William A. Weeks, Assistant Director of Communications, Continental Airlines Inc.:

"Electronic equipment in Continental's Club Coach planes is extra-dependable because of G-E 5-Star Tubes!"

"Everything about our new Club Coach DC-7Bs is superior. That includes communication facilities, and radar and other navigation instruments. Their reliability helps us keep the fast, on-time schedules that are a part of Continental's Gold Carpet service.

"One reason—and a big one—for the dependable performance of our electronic equipment, is tubes such as the one I'm pointing to: 5-Star Tubes built by General Electric for air, military, and industrial markets requiring highest tube reliability.

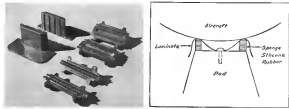
"Their failure rate is extremely low, and they outlast regular tubes by a wide margin. Continental's records prove both statements. Also—due to their tremendous war-time—5-Star Tubes help keep our costs down. They cut our need to pull faulty electronic equipment and send it to our Denver shops for overhaul. This is

expensive in operating dollars as well as in flight delays.

"Continental looks on General Electric 5-Star Tubes as an important part of its effort to give the public the newest and best in air travel."

Reprints from Continental Airlines' favorable equipment literature for your local G-E tube distributor include: 5-Star high-reliability tubes. Please send *Distributor Sales, Electronic Component Division, General Electric Company, Greenburgh, Kentucky.*

Progress is Our Most Important Product
GENERAL ELECTRIC
1951-52



SILICONE Latelyth (left) and control cables passing out of personnel area and silicone sponge rubber blocks (right) cushion No-shaped landing gear between B-56 and external weapon pod.

the last and also absolutely transparent rubber of my kind on the market.

Holding the safety glass "sandwich" together in a tight but without gap, Type K keeps the windshield clear and transparent at temperatures as high as 750° (roughly Mach 3.5).

Another new application calling for silicone rubber is the modified polyethylene take-up "spring wall" between the aircraft and the pod which is attached under the fuselage. Fabricated in an "M" shape, this plastic spring and prevents turbulence from occurring between the two sections of the airplane. To help prevent the seal and to cushion the spring, blocks of silicone rubber (sponges) 1 in. x 1 in. x 1 in., are attached to the plastic about one foot apart down the full length of both legs of the "M."

Pod Eleven Application

The area into configuration of the B-56 requires that the shock absorber be located far ahead of the wing with the result that heat from their exhaust must impinge on the weapon pod and the area and ahead of the wing stream. The pod closes the rear of solid silicon glass laminate. Regular sections of silicone glass laminate are also used to insulate on both the plane and the weapon pod, partly for heat resistance and partly because they are transparent to ultra-high-frequency waves.

Another use of silicone which has been widely used on the B-56, Porter said, was a glass-filled silicone molding compound, Dow Corning 945. This was used for the inter-type fasteners carrying aluminum steel control cables through pressure bulkheads. In addition to heat resistance, this material had to have impact resistance.

Following the responsibility material in weapon system development, Con-

rad used military and manufacturer's specifications as guideposts—not final design criteria—according to Concor's Porter.

Materials were selected on actual performance in such specific applications, and on several occasions the material was effectively pushed far beyond theoretical limits.

Operating Temperatures

Top operating temperature for silicone rubber, for example, is considered to be in the neighborhood of 1000°. But on the B-56, silicone rubber O-rings on a hose between line couplings are exposed to 600° for 20-30 min. at a time without evident deterioration.

On the other hand, the brittle point of silicone rubber is considered to be about 110°. But several silicone rubber O-rings (22) coupling in the plane's air conditioning lines maintain complete flexibility and resistance to vibration as long as two hours at -130°.

The original B-56 design called for suitable seals in the line couplings, while the air two seals were to have static seals. Later the air seals were also made suitable.

Silicone Rubber Seals

The forward canopy and was an inflatable seal utilizing neoprene rubber. Due to low temperatures, that type suffered after exposure to low temperatures were for relatively short periods of time. As a result, Concor switched to its flexible seals constructed of silicone rubber.

The seals are mounted in the canopy, fitting directly against the metal fuselage frame. Because the pilot's compartment canopy seal is subject to the greatest deflection, it has a much stiffer head. The others are seals welded on the wing edge. Backed with dacron cloth, they are sealed at an inflated pressure of 15 psi. to ensure

their maintaining 12 psi. in service.

Other applications for silicone rubber come about through certain air developments in the B-56 weapon area itself. This aircraft, for example, is believed to be the first to incorporate a rubber air seal and in the fuselage. In single sections of silicone rubber, 1 in. per leg, 1 in. thick and about 4 ft. long, is mounted but not connected between two outer structural members so that the end of one leg is flush with the bottom of the fuselage. Seal to maintain full resistance, it effects a pressure and pressure to the plane.

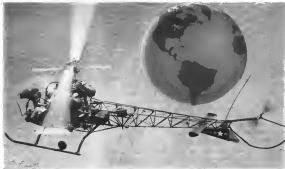
The sealing effect which put feel on the silicone rubber was used to make sure that the Green glands around the fuel cell both maintain a tight fit. In this case sealing was desirable but Dow engineers said that now, because of the silicone rubber, they have succeeded in fuel glands over large areas where the sealing might cause induced deformation.

Fuel Cell Protection

In applications like the Fuel Cells, where present silicone rubber must be protected against fuel cell and hydrolytic fluids, fluorocarbon tips with a silicone plastic acetone adhesive (Dow Corning XG 269) was required around the gasket. Dow said that the assembled gaskets cost 3.5¢ each.

Silicone rubber seals were required between guns on the landing edge of the wing to seal the movable edge covers from the engine pylons. D. Gubler said the seals on ducts from the engine thrusts inside the nacelles. These seals are subjected not only to an increased heat but also to radiant heat from the engines.

All general purpose electrical wiring is silicone rubber covered. For the sake of consistency and subsequent



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Bell H-13 helicopters have accumulated the equivalent of nearly 300 years of actual flight experience...tested under real-life conditions of weather, altitude and terrain.

Even Bells own rugged, controlled tests over the past 15 years, important and revealing as they are, can't match this true test of dependability...trial by fire. And the Bell H-13 series helicopter has come through that test with flying colors. With its more than 2,500,000 hours of flight time, it has proved its dependability, its ease-of-use, its versatility in operation throughout the world. Today, as it will be tomorrow, the Bell is the pacesetter in the field of utility helicopters.

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BELL H-13H FEATURES:

1. Longest approved overhaul period
2. Interchangeable main blades
3. Cyclic boom (power steering) that compensates lateral load designed and developed lock and load valves.
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DERATED ENGINE PROVIDES:

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THE NEXT STEP...

With the launching of his first satellite man finally has passed the thin envelope of atmosphere that separates him from outer space. He is ready for the moon.

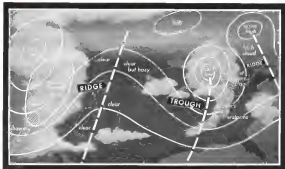
In preparing for this next step, Perkin-Elmer has used its unique capabilities in optics, electronics and mechanics to develop many instruments essential to our conquest of space. Among these are sensors for guidance of missiles and satellites such as tracking telescopes, alignment theodolites and satellite cameras.

Still others are for use in the U.S. satellite itself—infrared detectors, light weight optical systems. And Perkin-Elmer Vernastar® devices also play a vital role here in precision control, both ground and airborne.

Confusing information on the progress of this space instrumentation program is contained in "Optics Plus," P-E's new monthly news organ. Your name will be added to the mailing list on request. Write us at our main office in Norwalk.

Perkin-Elmer Corporation
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These weather lenses prepared in consultation with the United States Weather Bureau



CIRCULATION PATTERNS

Clockwise circulation of an around High Pressure area and counter clockwise flow around Lows in the northern hemisphere are well known to most pilots. However, there are some lesser-known features of Highs and Lows which have become apparent with the progress made in upper air analysis.

Warm Highs—Extend to levels above 10,000 ft. with temperatures generally warmer than Standard Atmosphere. As the type of High extends further aloft, it often assumes an elongated shape with major axis lying N/S to form a Ridge. This Ridge normally moves very slowly, blocking outward movement of weather systems

at lower levels, often causing prolonged periods of flat or murky weather in adjacent areas. Weather in Warm Highs is usually dry, flat and often hazy.

Cold Lows—Extend to high levels with temperatures generally colder than Standard Atmosphere. These are cold outward movement slow and sometimes the center aloft becomes stationary or even retrograde westward. This is called a Cold Low because of commonness of cold temperatures near the center. V-shaped elongation of these Lows toward the south is referred to as a Trough and marks regions of wind shifts and possible clear air turbulence.

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Mobilgas Aircraft and Mobiljet fuels!

For piston engines: Mobilgas Aircraft helps assure availability of full power from takeoff to landing.

For jet engines: Mobiljet fuels available for wide economies in flight temperature conditions. Free flow assured under all conditions. Excellent thermal stability.



Leader in
lubrication
for 61 years

MOBIL, MOBIL GAS COMPANY, INC., and AIRBORNE MOBILGAS PETROLEUM COMPANY, AIRBORNE, PETROLEUM GROUP, MOBILE, OBERLIN, OHIO, INC.

monitors, the wing is even used when it is not actually exposed to extreme temperatures.

The wing is connected with hundreds of multi-conductor plugs, all of which are filled with silicone rubber for a positive, crack-proof seal. The sealing faces in these plugs are also sealed with high modulus silicone fluid to help lubricate the connector pins and for an extra margin of moisture resistance.

All internal connections are coated with an air drying silicone resin filled with 2% titanium dioxide. Featuring high surface strength and excellent resistance, the film can be painted and roughed for easy maintenance.

All the wiring, as well as the pressure and incidence "blanking" is held in position with literally thousands of silicone rubber bands. Along the base pass through spurs and ballheads fitted with molded silicone rubber grommets.

The pilot's in-flight footing tube from the canopy-mounted seatback fan liquid is also silicone rubber. Vibration stability is obviously less important in this case than the fact that all of the most critical seals, certain silicone rubbers are completely resistant and do not support any trace of odor whatever to liquids.

Still in Development

Now and that silicone rubber is still in the early stages of development. Several new types were introduced after B-50 design and material specifications were completed. For example, in the windshield for the prototype model, the most of specially-treated seals for each of the irregular shaped, compressed curved windshield panels would have been high. But with strips of silicone-rubber stock, plus a new silicone-curing silicone adhesive (Dow Corning A-6600), Corning was able to make its own seals. As such wide and A in thick, the strips are connected to the cockpit side of the panel between the exterior sheet of glass "outer glass" window and metal framing. Their parts are made at each corner and followed out with 3 in. cork bonding tool. The hole was filled with silicone rubber paste, covered with cyanoacrylate and reinforced with a backing wire. The joint between exterior sheet of glass and metal frame is filled under pressure with a moist impregnated silicone rubber. Dow Corning RTV Silicone.

This last material proved useful in a number of sealing and filling applications, according to Porter. Easily molded, dipped or extruded in place, it served as a sealant for an anti-vibration smoothing compound for belly and upper fuselage, and as an adhesive for attaching other silicone parts to metals. The multi-layer sheet seal mentioned,

for example, is mounted in place with the RTV Silicone. Surface preparation was fairly simple: wipe down with low flash solvent, apply and scrub a silicone primer, apply the RTV. When the RTV becomes tacky, the silicone rubber joint is pressed into place.

A different medium temperature curing silicone rubber, Silastic 6112, was used to fill and seal the internal joints on the stiffening and supporting frames for each of the standard steel windshield panels on the wing elements and the "islands" between them. These panels are interchangeable between top and bottom of either wing, and therefore even though the materials are subject

to engine exhaust, silicone rubber was used on every panel.

Silicone rubber was applied to the antenna sockets and even coated the five antennas at 1500'. Primary purpose of the seal was to prevent moisture entering during the subsequent liquid heating process and to harden condensation during flight. After the patch work was done, they were wiped down with low-volatility silicone fluid to prevent hangover during storage.

Other silicone was on the B-58 included a silicone fluid vacuum support blended into the substructure hydraulic fluid and point inside engine nacelles to prevent corrosion at 700F.

marion

ELECTRICAL INDICATING INSTRUMENTS

WHERE ELECTRONICS MEETS THE EYE

Marion electrical instrument company
Rochester, New York

advance design

high temperature
reinforced plastic
ducting



*Service Temperature for Fillmore
Brins and Fiberglass Laminates:
Operating Temp: -120° thru +500° F.
Short Exposure: -120° thru +600° F.
Baking Time at Maximum:
-120° thru +400° F.*

LOOK TO ARROWHEAD for advanced design—new ideas, new materials, new techniques—like this new fiberglass-aluminum resin Starjet Duct Support in the B-54 Super-sonic Bomber. With a weight-strength ratio many times greater than steel, this high temperature resin part offers the ultimate in serviceability at extreme high and low temperatures.

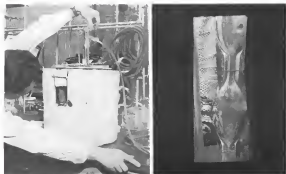
Arrowhead Research and Development facilities are

available to help you solve your ducting problems. Only Arrowhead has the experience, the ability and the facilities to answer all the problems, because only Arrowhead produces all three basic types of aircraft ducting—stainless steel, rigid plastic and flexible fabric-rubber.

Write for service or consultation on advanced design projects. Arrowhead field engineers are located in all aircraft centers.



2389 Curry Street, Long Beach, California



TECHNICIAN checks flow of Versilube fluid heated to 710° in oven at GE's Silicone Products Dept. laboratory (left). At right is showing through electronic window in oven showing fluid flowing through insulated Orford pipe with oven temperature at 710°.

Hydraulic Fluids Resist 700F Effects

By George L. Christian

Watertown, N. Y.—Two newly-introduced high temperature silicone fluids will help the aerospace industry push into the region of Mach 3—about 2,000 mph—because of their ability to operate satisfactorily at temperatures up to 700° F.

One, presently a hydraulic fluid—also integrated with high temperature hydraulic system developments in 700° prototype pumps being built by New York Air Brake Co. and GE's Vitro-A seals available from the Ford—presents a true breakthrough from the 350°-450° ceiling imposed on today's hydraulic systems by temperature limited fluids, seals and components. Boeing Airplane Co., and some of its subcontractors at New York Air Brake are doing extensive work with the fluid in connection with the chemically-inerted WS-198A bomber project.

The two new fluids, developed by General Electric's Silicone Products Dept. here, possess improved lubricity and oxidation qualities especially over an existing, lower temperature silicone fluid developed by General Electric two years ago. All three fluids are called Versilubes.

New Versilubes are

• 81717—High intensity fluid is introduced primarily for use in hydraulic systems which will withstand prolonged use and provide good lubricity at temperatures ranging from 100° F to +600° F. Under certain operating conditions fluid will give good service to 700° F. Fluid was developed under an Air Force contract between the Materials Labo-

ratory, Wright Air Development Center and General Electric.

• 81644—High oxidative stability fluid was developed for use in engines and other lubricating systems where exposure to air cannot be controlled. Fluid remains completely stable to oxidation at temperatures up to 710° F, 10-50 deg. higher than was possible with previous

Physical Properties of 81717 and 81644 Versilubes

Versilube		81717	81644
Viscosity-Temperature			
Data Represented	Temp. 91	Centistokes	Centistokes
	-45	3407	2848
	-30	846	708
	0	390	313
	+100	71.3	45.4
	+300	12.9	13
	+450	3.5	3.2
	+700	1.9	2.4
Color		Water White to amber	Amber
Flash point		Below -100° F	Below -100° F
Pour point		52° F	50° F
Specific gravity at 60° F		1.53	1.64
Bulk modulus		150,000 psi at 72° F	150,000 psi at 72° F
		30,000 psi at 700° F	30,000 psi at 700° F
Panel rating		0.0 mg. at 600° F after 8 hr.	1.0 mg. at 600° F after 8 hr.
		6500 mg. at 750° F after 8 hr.	3.0 mg. at 750° F after 8 hr.

WHO is America's largest producer of jet engine roller bearings?

HYATT of course!



WHY?

- 1 FLEXIBILITY.** HYATT is always happy to cooperate with aircraft engineers seeking new ways to break "bearing barriers" of higher speeds and temperatures. *We're glad to explore unorthodox designs.*
- 2 KNOW-HOW AND FACILITIES.** HYATT has what it takes to turn out ultra-precision bearings that perform perfectly on the "green run" at speeds up to 75,000 RPM. We've built for more jet engine roller bearings than any other manufacturer.
- 3 PLENTY OF TOOLING.** HYATT doesn't let you down once the prototype is approved. We've got the tooling to produce promptly in quantity—maintain both rigid precision and production schedules!



To break "bearing barriers" in a hurry, call HYATT for help! Write for new Aircraft Catalog A-26. Hyatt Bearings Division of General Motors, Warren, N.J.

HYATT HY-ROLL BEARINGS
FOR AIRCRAFT INDUSTRY

1,000°F Hydraulic Systems

General Electric engineers, in discussing very hot hydraulic systems—1,000°F or more—suggested that their developments may be necessary to make these practical systems feasible for example, liquid metal fluids, such as NaK, 77 (AW Nov. 11, p. 69), all metal seals or lap fits to eliminate seals.

phones and other high temperature lubricants. General Electric says that S1644 is also a somewhat better lubricant than standard lubricating silicone fluids. It will also operate at 700°F under certain conditions.

Both S1717 and S1644 are based on General Electric's first high temperature chlorinated fluid, Vershlole F-50, which possesses the best thermal stability of the family of three Vershloles. It is also the only one of the three that contains no additives.

General Electric says that, prior to F-50, which silicone fluids were known for their thermal stability over a wide range of temperatures, these lubricating qualities were poor. F-50 fluid gives good lubricity.

Broadened Horizons

With the introduction of these three fluids, machine designers will broaden the design horizons and provide greater flexibility in the development of hydraulic and engine lubrication systems for aircraft and missiles and will enable or eliminate the necessity for cooling hydraulic or engine oils. As General Electric technicians point out, the two of fluids allows system designers to choose a fluid for its lubricity, resistance to oxidation or for its thermal stability, depending on the particular design requirements.

All three fluids will burn at very high temperatures. Their auto-ignition point is over 800°. One point where they have not exposed to an igniter source ranges from 620°F for S1717 and S1644 to 650° for F-50.

At 700°F, the two new Vershloles have a breakdown rate of 2% an hour. Breakdown starts at 660°F, varies directly with temperature and remains constant at a constant temperature.

Both exhibit excellent gas lubricant properties.

Safe Handling

No special precautions are required to handle any of the Vershloles.

However, the high temperature (314°F) silicone ester base hydraulic fluid currently used in the B-26 Destroyer-Observer 8133 (AW Nov. 11, p. 69)—requires that special precautions be taken with a hydraulic system using it.

Aerospace are soaked out to avoid

Micronics IN ACTION

... 3... 2... 1... 0
scratch one raider!

ELGIN safety
and timing systems
and fuses make sure
the "count down" is safe
... yet deadly

"Inherent" is an empty, scientific name, even severe destruction of the target is achieved. It follows that the success of a guided missile can be accomplished only as effectively as its engine is armed and fired. Safety before launching and reliability of all timing after launching are prime considerations. Elgin has the specialized skill in development and manufacture of fuses, safety and timing systems to bring an explosive mechanism to its destination.

Elgin offers its complete range of specialized production and research facilities in Elgin, Illinois; ... Lincoln, Nebraska; ... and Chatsworth (Los Angeles), California; ... to all manufacturers requiring precision timing, fuses and timing systems, safety and timing mechanisms are now used in B-26, SPARROW and SIDEWINDER. One of the Micronics Division of Elgin's for year design and manufacturing requirements.

Elgin's rapidly expanding facilities and staff now offers a broad scope of opportunities for qualified engineers and technicians.



ELGIN NATIONAL WATCH COMPANY
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SAME SYSTEM



SMALLER, MORE EFFICIENT UNITS

Research on airborne hose reel units of the reliable Probe and Droque aerial refueling system has, in the space of only three years reduced both the size and weight of the tanker units, and provided significantly greater fuel flows at higher operating altitudes and speeds.

Latest in the long line of refueling equipment, designed and produced by Flight Refueling, Inc., is the efficient, hydraulically powered reel unit A-29 for Navy's FJ-4 "Buddy" tankers (above, right). The magnitude of engineering refinements incorporated in this latest design is evident when the picture of the new reel is compared with that of its larger predecessor, the A-12-B (left), for Air Force's K3-B, multi-point tanker, which was produced first about three years earlier. Not only does the A-29 come in a smaller package, it has more efficient controls, faster response approximately equal fuel flow, a wider range of refueling altitudes and speeds, and is much more accessible for maintenance.

Applied research at Flight Refueling, Inc., is directed toward solving the complex fuel transfer requirements of military weapons including missiles and rockets as well as manned aircraft, ships and other mobile equipment.

If you have a perplexing fuel handling problem, Flight Refueling's engineers will be pleased to discuss it with you, and suggest practical methods of solving it.

ATTENTION Engineers

Unusual career opportunities for engineering personnel are available in new projects for developing new refueling systems.

Write Engineering Manager for details.



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8-401 Carol William E. Clark, Box 617, Redwood, Calif.
Deputy Fred J. Karsch, Box 617, For Hill's Inc., Dayton 9, O.

Herman Nelson PORTABLE HEATING and VENTILATING Serves the Defense Establishment Everywhere



On Land Speed and maneuverability are two of the advantages offered by Herman Nelson portable heaters. For time-saving truck engine warmup, ET400 unit slides out fast, starts up in seconds, delivers volumes of heated air for quick truck starting.

On Sea When the Marines land, there ET400-3 portable heaters are fixed in with them! Such versatility is but another feature of these efficient units—evidence from Herman Nelson's 35 years of experience and leadership in the portable heating and ventilating field.

In the Air Dependability, too, is of utmost importance to the Defense Establishment. That's why Herman Nelson portable heaters will be found around the globe burning efficient, fast heat for airplane pre-flight maintenance. Let Herman Nelson's experience go to work on your next portable heating or ventilating problem.



American Air Filter

COMPANY, INC.
Greenville, Kentucky

DEFENSE PRODUCTS DIVISION

models and hydrolysis. Field is driven into system from storage container by pressurized nitrogen.

- Nitrogen atmosphere maintained on ground test equipment.
- Chromic 8845 kept from contacting iron with any other fluids.

None of these precautions need be observed with the Versalabs. They can be handled just as standard petroleum-based fluids are.

Exposure to air has no effect on the fluid, and they can be contaminated with water to some degree without harm. Nitrogen atmosphere is never required.

Chromic 8845 has somewhat better lubricity characteristics at temperatures up to 4900° above which 81737 takes over it, according to General Electric engineers.

Although 81737 was developed by General Electric under contract with Wright Air Development Center, Dayton and T-10 fluids are a product of General Electric's independent research in the field of silicones.

To investigate the entire range of fluid properties at temperatures ranging from 100° to 700° required considerable original thinking, improving specialized test equipment and developing critical new products of fluid property measurements.

Laboratory Developments

Here are some of the laboratory developments accomplished in the company's temperature-silicone fluid research.

- Determination of a new method of measuring fluid viscosity across the standard fluid viscosity versilabs VI, in viscosity studies, has an advantage for silicone fluids. General Electric developed a new, measuring measure called VTC—viscosity temperature coefficient.
- Modification of four-ball laboratory tests to characterize viscosity, contact which would prove hazardous when heated due to 700° stress gauge was added to the test to measure torque produced by the rotating viscometer.
- Development of methods of determining whether fluid breakdown is due to oxidation or heat and establishment of methods which assure that fluid's breakdown is due entirely to one cause or the other.

- Design and building of specialized test equipment and development methods to handle fluids safely at the temperature extremes of 190° to over 650° 700°.

Characteristics of Versilabs fluids include:

- Fluids are colorless non-toxic to metals. Since they do not contain rust precipitants, exposed metal surfaces may corrode due to water or other vapors.
- Versilabs are completely chemically

stable under long storage conditions. T-10 has been stored for over four years without any detectable change.

- Developed studies on the fluids are not complete.
- Fluids are not immediately resistant. Large doses of oxidation attack the silicone atoms and gelation of the fluid occurs. Therefore Versilabs cannot be recommended for applications

where high oxidation concentrations are present.

Spontaneous ignition temperatures for all three fluids is about 510°. The temperature remains the same regardless of whether the fluid is under pressure, is getting at it in a vaporous state.

All three Versilabs are being tested in various applications on a variety of burning and up-coming results.



T-10 rig supports pack unit surplus flip structure to rise, lower pack. Unit weighs 210 lb.

Helicopter Weapons Pack Readied

First model of General Electric Co's lightweight gun-and-rocket fireproof pack for Army helicopters (AW May 20, p. 32) is scheduled to go to the Army Aviations Board at Ft. Belvoir, Ill., for tests.

Reconnaissance and utility helicopters can carry two packs each for suppression of ground fire. Pack carries two 2.75 in. M-60 ground guns, which have 100-900 yd. range and eight 1.5 in. (7.62 mm) 40, armor-piercing rockets. Rocket tubes can be slanted for 2.75 falling 40 rockets by motion of lever. Guns are quickly detachable.

Pack is made of magnesium and weighs just over 100 lb. It is manufactured by Buelco and Perleco, Inc. Pack is held in an "H" frame which is built in behind the helicopter's main engine. Tests on a National Guard Bell 47 type, which has the least ground clearance of the smaller helicopters, indicate pack will clear ground safely and without major landing.

Guns are held in pack by three FIP gun. Ammunition can, carrying 500 rounds per gun, is held in a falling door at side of pack.

Maintenance and logistic problems are kept to a minimum by use of standard parts and standard Pack system includes no electronics—only a

photo of the computer logic. Internal motor in cockpit programs rocket firing sequence.

Secure switch on pilot's cyclic control stick keeps him from firing guns and rockets at the same time.

Rockets can be fired singly, or pairs or in volleys up to 16. Selection of firing pattern can be made on the ground or in flight. For large volleys, rockets are automatically fired 28 milliseconds apart.

Test rig was a surplus flip structure (see picture) to test and lower pack, giving pilot control over direction of guns and rockets in later models electronic control would be built in the pack itself. Packs can be mounted or removed in five minutes.

Guns can be slanted on the air by means of a cable. Rockets are aimed in flight with a control switch on a pistol. Guns are fired by means of a solenoid used to pull the trigger, and rockets are fired electronically. Gun's belts are locked for loading.

General Electric has fired some 5,000 simulated T-10 gun NATO rounds from the guns but has not fired rockets from the air. General Electric and Buelco and Perleco have developed the pack with their own fluids. Estimated production cost is \$1,000 per pack.



Announcing a specialized MISSILE SUPPORT SERVICE

You worry about the missile... let Packard Bell Electronics take care of ground support! Proven performance in this field has resulted in a separate missile equipment section devoted exclusively to ground test and launching equipment. Here, in a 21,500 sq. ft. facility geared for short run production, experienced men agree on shoulder complete responsibility. Here the most radical design changes are absorbed during the process of development. Here direct assembly supervision by production engineers eliminates costly and time-consuming delays. A reliable source, any way you look at it. And a reliable way to rid yourself of a major headache!

ENGINEERING BEYOND THE EXPECTED



This revolutionary MAGAMP power supply delivers a 275 v. 100 amp. at 400 Hz. 500 watts, regulated at or load up to current loaded for more.



The MAGAMP has a surge capacity of 100% overload for 2 seconds. Regulation in the load is 1% or better. Efficiency factor is less than 50 milliwatts. Overload and underload are less than 10%, with a 10% change in load 1% or less on the photo. 5V/0.1M and 10V/0.1M.

DESIGN—When time duration available equipment can be adapted to your specifications. But you receive custom design, beyond the expected, when you seek it. For example, the manufactured MAGAMP power supply delivers a 275 v. 100 amp. at 400 Hz. 500 watts, regulated at or load up to current loaded for more.

DELIVERY—A contract from Douglas Aircraft for "Box" test equipment was awarded in March 1956. A total of 100 units comprising 30 different units, was delivered before deadline in November. On time delivery is its best—delivery beyond the expected.



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U.S.A. Representative: Vernon Crudge Room 1531 610 Fifth Avenue New York 20

Mockups Aid Douglas Jet Noise Studies

New York—Top priority tests of three basic methods of sound suppression for DC-8 jet engines are producing encouraging results, according to Douglas Aircraft Co.

To date, more than 1,000 tests have been conducted to measure the effect of construction and modification of the three fundamental sound suppression methods.

Thrust-reverser development is associated with the noise suppression program since both are on the propulsive jet exhaust at the same end of a gas turbine engine.

Full-Scale Mockups

While much of the test program has been done with 10% and 20% scale models, a number of full-scale mockups are now under test to develop and prove required endurance and reliability of operations.

Jet engine noise is caused by the shock along the surface of hot traveling exhaust gases—up to 3,000 ft/sec—flowing through stagnant ambient air (AVR Sept. 3, 1956, p. 54).

Muting the jet exhaust with the ambient air will result in a reduction of the noise.

Three basic methods of accomplishing this muting are being investigated by Douglas:

- Replacing single, large nozzle with group of smaller ones
- Intercepting exhaust of exhaust stream by moving nozzle shape
- Adding an cyclonic tube around nozzle so that exhaust itself will become case of rapidly moving cold air stream. (Bypass jet engines use exhaust, less noisy than other jet types because bypass air reduces density gradient across heat plane between engine exhaust and ambient air.)

Douglas engineers are also now adding significant gains by combining elements of all three methods of noise suppression.

Jet Nozzle Flaps

One of the Douglas designs uses flaps around the jet nozzle to divert air away in side air. A check-valve device on moving device is included on the same mock-up.

Douglas says that test data indicate that jet engine noise can be controlled and thrust-reverser accomplished with minimum penalties in weight and performance.

Company says that "the encouraging results obtained to date may well be surpassed by the increasing systematic program of analysis and development which will assure effective and efficient design for the DC-8."



LIGHT sound suppression flaps around DC-8 jet engine exhaust mockup (above). Four meter flap exhaust and thrust-reverser flap closed, fully extended, are shown below.



AVIATION WEEK, November 18, 1957



NEW, 400,000 sq ft Fuel Control Building is in progress. Behind it, 1 million sq ft main plant. Concrete circle is helicopter landing pad. Bradley Field is in background.



BATTERY of five fuel control test stations already in operation in Hamilton Standard's new Fuel Control Building. Tests check each condition in unit's fuel entering aircraft.

Fuel Controls Facility Dedicated

New 410,000-sq-ft building housing equipment for the development and production of fuel controls for turbine engines and other engines was recently dedicated by Hamilton Standard 125 years of United Aircraft Corp. at Windsor Locks, Conn.

Production lines in the new building which will house 2,500 employees, are already moving.

Separate, research facility, included in the dedication, is equipped to test

computer products with all types of engine fuels at very high or low temperatures.

New buildings will house floor space in the company's Connecticut plants to a total of 1,750,000 sq ft.

Hamilton Standard Division is also producing aircraft air conditioning systems, gas turbine engine starters, hydraulic pumps and other accessories for the turbine and piston fields (AW Oct. 21, p. 392).

German Airport Installs Hydrant Fueling System

Born-Ehrhart fueling system is to be installed at Frankfurt Airport will be fed by 10 underground tanks each with a 26,400 U.S. gal capacity. Provision is being made for 10 fueling stations with one hydrant each for piston-engine planes and four additional positions with two hydrants each for jet air craft. With the dual hydrant outlet jet planes can be fueled at a rate of 1,500 gpm which means that aircraft with capacities of 15,000 to 50,000 gal can be fueled in approximately 15 min.

Hydrant fueling system is being built partly by Flughafen Abtgesellshaft Frankfurt (the airport shareholders) and Esso, A.G., Hahnburg, a subsidiary of Standard Oil Co. N.Y.

OFF THE LINE

Roemer Motors, Inc. reports that 95% of its prospects to airlines and vehicle manufacturers under license contracts were made in 1,400 small business cars since during the period from Jan. 1 through Oct. 31. Small business is cited \$5,678,000 out of a total of \$10,017,000. Small businesses are firms with 5,000 or less employees.

Profits of Roemer's Corp. for the company's first fiscal quarter, which ended Sept. 30, were 5.5% higher than for the same period last year. Quarter sales totaled \$1,081,125 and profits after taxes were \$894,903, an increase of 17% over the corresponding period at 1956. Stock-out on delivery schedules required management economies, including the lay off of 113 employees. Earnings per share of common stock were 10 cents for the first quarter of both 1956 and 1957.

Passenger seats for Lockheed's newly rolled out Electric jeep jet aircraft will be supplied by Aerotherm Corp., the new company which will supply all the seats for Pan American World Airways Boeing 707 jet transports. Electric seats are a result of a 30-month joint development program by Lockheed, Heery Division industrial designers and the Aerotherm Corp.

New high energy horse fuel, HiGAL, will be available to the public for the first time during the 1958 Chemical Industries Exposition in New York, Dec. 2-6. Fuel was developed for the Navy by Collier Chemical Co. Other Galen products in display will be decal burners, shaver, more, hairbrush, post-urine and barbershops and the alloy bar and group.

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Here's an entirely new chair concept to meet current need for ultra high density seating. Its clean sculptured lines impart a feeling of spaciousness, yet design simplicity permits substantial savings in weight, space,

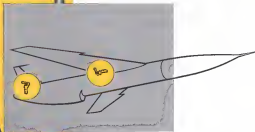
and cost of maintenance without sacrificing passenger comfort. The Starest reflects Hardman's years of design-manufacture experience. It sets new high density passenger comfort standards for any aircraft.

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Modern warfare weapons—that guard and protect...are highly complex devices. They must be dependable for instantaneous service—even after an expendable shelf-life.

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When it's a sealing problem, call on LINEAR or one of its agents for engineering assistance...

and be sure to specify LINEAR "O" Rings for prototype or production.



NEW AVIATION PRODUCTS

Elephant for Magnesium

Magnesium elephant 10654 is a granular product that chemically seals magnesium alloys, excluding nonferrous alloys, at 1 to 1.5 mils/sec. With rate decreases with increasing temperature. Material costs in dollars containing 430 lb.

Research Dept., Wausett Chemical Corp., Wyandotte, Mich.

Water-Cooled Torch

Welds comparable in strength with spot welds made in conventional resistance welding process—relative to gap thickness and size—are possible using new T-600 water-cooled tungsten inert gas welding gun, the manufacturer reports.

The Wausett torch has transparent nozzle to facilitate viewing weld in process. Work can be done at three or 150 amp without need to change torches, under water. An additional heating unit permits operation with a selection of weld depth penetration of any two spot applications without having to make adjustments at the power source.

Tech Torch Co., Inc., 300 Peterson Ave., Caldwell, N. J.

Salt Spray Fog Unit

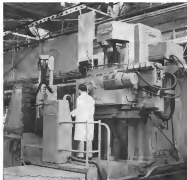
Salt spray fog test cabinets ranging from 10 ft x 10 ft x 10 ft wall-on room type to 2 ft x 2 ft x 2 ft unit, are designed to meet military specifications for equipment testing. A thermostatically controlled radiant heating blanket is used for temperature control and to maintain control in one-half degree.

Chambers feature hydraulic cover-



lifters, automatic level control of humidifying tower and air pressure regulation is standard equipment. Optional equipment includes gas through, via drive, pH meters and electrical and hydraulic connections.

Development Engineering Co., 9 Court St., Norwalk, Conn.



Northrop Installs Tape-Controlled Machines

Three of these 54-ton numerically controlled Kearney & Trecker profile milling machines will be installed in Northrop Aircraft, Inc., facilities by the end of this year. Machines will be used for work on the S-600B tank truck, 1-35 supersonic fighter and subsonic work on other models and aircraft.



Chamber Provides Humidity

Relative humidity from 20% to 95% can be automatically maintained or varied in accordance with arbitrary specifications, temperatures of 0 to 200° can also be provided in environmental chamber T18-F0 27-10L. Use



One-Inch Flow Unit

Flow atmospheric device in one-inch size will detect flow of one-quarter to one-half gal per minute and activate a switch for indication or control in systems.

Explosion-proof one-inch orifice vent single 12 in., 14 in. vent 16 in. and two-inch version 20 in. One-inch vent will indicate flow down to 0.1 gal/min. If, after a valve has been closed, there is leakage into the line, according to the maker. Gaspass also points out that equipment will operate in any attitude as liquid or gas and can be completely submerged. Normal operating temperature range is -55° to 150°.

Patterson Instrument Corp., Route 22, Union, N. J.

occupies work space of 35 in x 35 in x 35 in.

Circular chart can programming controllers are used to handle both wet and dry temperatures.

Leatherman Co., 13299 Sherman Way, N. Hollywood, Calif.



Westinghouse metal miracles boost jet engine performance 15%

Turbjet "hot end" parts, made from clad molybdenum, are increasing jet engine efficiency up to 15% by permitting higher turbjet operating temperatures. Developed by Westinghouse research scientists, this new method of coating molybdenum to prevent high-temperature oxidation has proved successful during extended engine testing of "clad-moly" parts at temperatures above 2000°F.

Development of this protective coating—which results in hot and effective alloy molybdenum alloy sheets or shapes are formed into parts of complex shapes—is part of the advanced metals research program at Westinghouse. The Aviation Gas Turbine Division is helping to keep America strong by applying this coating and other new research developments to create better and better jet engines for the defense of America.

Take advantage of Westinghouse's ability to engineer, develop and produce equipment for America's defense. Contact your Westinghouse Defense Products sales engineer, or write: Westinghouse Electric Corporation, Aviation Gas Turbine Division, P. O. Box 286, Kansas City, Missouri.

A-10307



The first stage turbine nozzles were developed in 1945 and chosen for engine testing as they are subjected to the highest temperatures and are most susceptible to thermal shock.

YOU CAN BE SURE...IF IT'S

Westinghouse



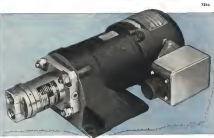


miniaturized motorpumps

...for Vanguard Earth Satellite Rocket Vehicle

Numerous Vickers miniaturized hydraulic elements have been intensively developed for use in the air without sacrifice of their inherent high efficiency and reliability. Representative of the "packaged" approach to dependable inside hydraulic power is the PVH-3904 electric displacement piston type pump shown here mounted on an standard motor. The pump has a theoretical delivery of 0.84 gpm at 7400 rpm and 1000 psi with a volumetric efficiency of 95%. The explosion proof motor has 6.0 in.-lb. torque from 6900 to 9500 rpm. The complete package weighs 8 lb. . . . 1 lb. for the hydraulic pump and 7 lb. for the electric motor.

The overall length is less than 10 inches. For further information about Vickers miniaturized hydraulic components and complete packages, ask for Bulletin A-5214.



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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1898

HUMAN FACTORS

Medical Group Reports on Pilot Fitness

By Richard Sweeney

Los Angeles—Progress in understanding the human factors of flight is higher and faster spectra was outlined at the Third Annual Aviation Medicine Symposium held recently, sponsored by The University of California at Los Angeles Medical School and Medical Extension. Those attending the two-day symposium heard reports on:

- Civil Aviation Administration plans to obtain more civil pilot physical fitness standards for civil pilots by gathering data under provisions of amended Part 29 of Civil Air Regulations, by Dr. James Britton, M. D., CAA
- Operational human factors problems with the F-4 by Capt. Arthur Greenhalgh, M.C., USAF
- Project Man High, biometrics, aerodynamics, by Col. John Stapp, M.C., USAF, Edwards Air Development Center, N. 38
- Army-Navy instrumentation program, Al Myers, Douglas Aircraft Co., El Segundo Division

Also given were papers on medical aspects of Laramie's high vacuum laboratory (AW Oct. 14, p. 61), General's Physical stress, radiation and dynamic vestibular exposure loading programs, work on man by the research center of the Smithsonian on Noise in Industry.

With the revamping of Part 29 of Civil Air Regulations which took effect last August, CAA intends to start a program aimed at updating physical standards requirement on a routine basis commensurate with the philosophy that every U. S. citizen is qualified for the right to fly an airplane. Dr. Britton told the symposium.

He pointed out that whereas the military consider it a problem to fit and apply physical standards on that basis, technique in the CAA philosophy is the fact that an adult citizen and a juvenile citizen are certified in the U. S.

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where restrictions were applied, but where substantial quantitative data might show that the restrictions do not preclude safe flight.

Under the amended regulation, a general medical examination will pass along to a special group in CAA's Washington medical section those cases which are applicable and the Washington unit will conduct a medical certificate for a strictly limited period of time, can be issued, or one calling for certain examinations at stated intervals is qualified medical comments. Close check must be under basic health and over a five-year period, Dr. Britton said, should yield excellent data for revising of that part of the regulations on a more realistic basis.

Indications also are that visual qualifications rules leave something to be desired, Dr. Britton said, both in the rules themselves and in the methods of determining the qualifications. Examples, he said, are the color discrimination test, the depth perception test, the determination of other visual conditions.

Great necessity for a realistic physical standards regulation, Dr. Britton declared, is the writing of a pilot's job description, covering what he does, what he must be able to do under what conditions and what physical capabilities he actually needs.

Overall physical fitness, Dr. Britton said, is a combination of many factors, some not even touched on in regulations, namely, emotional and mental stability. An element who leaves a person is physically qualified under regulations but is mentally as emotionally disturbed to the extent that he might be dangerous in the air, really must pass a certificate. Even if he does a certificate, the person can appeal to the Civil Aviation Board. Proving a borderline condition can be difficult, the doctor said.

Physical Standards

Concerning physical standards for jet transport pilots, Britton said new criteria may be suggested. He pointed out that in the past, successful demands were satisfied by experience in older pilots, but with the introduction of jets, older pilots will have limited or no experience in jets, and hence may face difficulties.

In addition, he stated, he expects the requirement for yearly electrocardiograms for transport pilots over 40 to become a C. S. regulation, possibly within a year.

Regarding decompression problems for jet transport passengers, Britton said indications are that oxygen drills must be accomplished by uniform, with a view toward making it a routine pro-



HIGH ALTITUDE flight preparation is uncomfortable for a pilot until the pilot's air crew debriefing begins to work. Test Pilot Robert Britton, Chester Wright Inc., showed a panel project unit, ozone oxygen cylinder that some have from time to time. "Understanding" in ozone tanks in flight tower until he plugs into NFPA oxygen supply. Cost spent has a long way to go in but in Dallas plant. Aluminum canopy that shields cockpit from heat has been tested. Flight was 4000 ft for the experimental success.



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also unsuitable for pilot reference. He also indicated in answer to an inquiry that questionable results about a new plane which provide its introduction are usually quickly ended when the airplane appears and proper reaction procedure are followed.

Engineers now in progress on body-dynamics—the effects of mechanical energy on living tissue—were outlined by Col. Stapp, who also showed motion picture of the billion flight of Maj. David Sarnau and his latest trajectory flight in a TF-102A for weightlessness exposure.

Supersonic Wind Protection

Col. Stapp's presentation covered materials not yet ready for general dissemination pending completion of three more experiments in wind tunnel at Holloman. However, he indicated prospects are excellent for protection of aircraft against supersonic wind effects by special clothing material in combination with the active protective devices now in use or being developed.

Work which will be done next spring at Holloman, Col. Stapp said, will include tests with one and forward facing airplane passenger seats, oriented toward gathering data on use of cut after airplane impact. Col. Stapp said he was sure that if seats are properly designed to stay securely fastened through crash decelerations and retain their structural integrity, that forward facing seats will enable passengers to get free, escape the airplane in case of fire or other mishap after crash landing better than forward facing seats. He said that persons will live through high decelerations in forward facing position, but that attendant dishing over somewhat reduces their ability to quickly release a safety belt and walk in the clear exit, while forward facing seats which absorb the drag loads will leave passengers in better condition to complete their escape due to distribution of acceleration loads over greater area.

If funds permit, further flight in the gondola used by Maj. Sarnau will be made, Col. Stapp said. A new balloon with 5 million cu. ft. gas capacity will be available, enabling flight in greater altitude.

The balloon used by Maj. Sarnau had 5 million cu. ft. capacity, carried passenger to what Col. Stapp said he is sure is at least 131,000 ft., but the true altitude will be unknown until the Bureau of Standards completes work with a sealed barograph which was aboard the gondola. New balloon should be, Col. Stapp said, capable of carrying the gondola and a 300 lb. payload to 150,000 ft. for an extended stay.

Other data determined from Maj. Sarnau's flight, Col. Stapp said, included a very low sonic radiation ef-

fect. In fact, strike plates showed little above normal background radiation. Cosmic radiation, he added, will not exceed measured altitude as noise in-house experiments. Records of altitude in 46 flights in which one animal was 44 lb. above 90,000 ft., bear out that it would take 2,000 lb. exposure there to accumulate 1 lb. the present Atomic Energy Commission allowable radiation exposure during a 10-yr. career working in radiation areas.

Stapp's job yet to be done concerning space flight, Col. Stapp said, is investigation of the effects of weightlessness. In the blood record of the TF-102A flights, exposures were showed

to first bar in the tubes, and a set was shown to have its ability to quickly twist about and bend but first when dropped from the left up position, under negative conditions.

Experiments with animals and man which experienced approximately 3 min. periods of weightlessness in rocket flights to 17 mi. indicated no change in the sensory system or observable emotional effects, he said.

General outline of the Ames-Navy astronautics program was given the afternoon by Al Muso. Data presented was in line with that given at a recent meeting in Los Angeles (AV Oct. 21, p. 34).

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A MESSAGE TO AMERICAN INDUSTRY • ONE OF A SPECIAL SERIES

BASIC RESEARCH . . . More Practical Than You Think

This editorial, one of a special series on the importance of research to the American economy, deals with an aspect of our research program that may have serious consequences in future years—the lag in basic research.

An earlier editorial in this series stated: "The long retreat of U. S. business from scientific research points the way to a new kind of prosperity for our economy—a prosperity based on deliberately continuous." As a result of the dramatic increase in industry's research expenditures, more new products will be introduced in the years 1955-1960 than in any previous four-year period.

A steady stream of new products and new processes raises living standards for consumers and lowers costs for business. And thus it promises to sustain a high level of general prosperity that defies the old laws of boom and bust. But, as we look further ahead, there is a danger that the stream of research discoveries may run dry because of our neglect of basic research.

This danger was described by John Jay Hopkins, late founder and chairman of the General Dynamics Corporation: "Unless there is a revolutionary development in America of pure, not applied, science, there will come a day when there is no one in leading in your old car, because the new one is no better. The only difference between this year's television set and next year's will be the appearance of the cabinet! Scientific progress will be replaced by scientific stagnation."

What Basic Research Is

Basic (or pure) research has been characterized as the pursuit of knowledge for its own sake rather than to fulfill some practical objective. It is generally carried out in an environment which allows the in-

vestigator the freedom to follow the lead of his curiosity. The scientist in basic research, in the words of Glenn T. Seaborg of the University of California, is not concerned with "utilitarian goals, but a search for deeper understanding of the universe and the living and inorganic phenomena within it."

Imprecise as basic research may seem in its initial purpose, it is an essential prerequisite to applied research and product development. A few examples will show how some of the greatest technical advances of recent years have come from basic research projects that had no immediate practical objective:

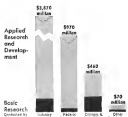
- **Radar**—an important military development of World War II with broadening commercial application—was the outgrowth of a basic research project whose purpose was to obtain information about the height of the ionosphere, the layer of air that has some 25 miles above the earth's surface.

- **Transistors**—the miniature devices which are almost vital components of hearing aids, pocket calculators and a wide variety of industrial equipment—were invented at Bell Laboratories (research subsidiary of the American Telephone and Telegraph Company) following university investigations into the electrical behavior of solids.

- **Nylon**—a synthetic rubber—was developed by DuPont with the help of basic information provided by Fisher Penland of Notre Dame, who discovered he could control the polymerization (the linking together of molecules) of a certain class of organic compounds.

- **Nylon**—the first of the successful synthetic fibers that have revolutionized the textile industry—grew out of fundamental research by Dr. Wallace Carothers on long-chain polymers.

**Only 6% of All Research and Development
in the U. S. is Devoted to Basic Research**



Industry's Stake in Basic Research

Industry traditionally has relied upon colleges and universities and other nonprofit institutions for basic research, and the U. S. has long benefited from the greater emphasis placed on basic research in Europe. It is conventional to think that basic research cannot, and should not, do much about "every power" projects which do not have immediate practical applications.

However, there is not so much in this idea as it appears. The examples above illustrate what Caryl Hinkley, president of the Corning Institution, has called "the widespread paradox that the most important practical consequences are normally the least sought after." Furthermore, it is certain that, without adequate basic research, industry's efforts to produce new and better products will become progressively more difficult. And as national defense, in an age of breathtaking military applications of science, will become increasingly preeminent.

In the past, our economic growth came largely through expansion into new lands or through discovery and development of rich deposits of natural resources. Such opportunities are relatively limited today. The great opportunities now lie in discovering new materials and new properties of the materials we already have. This is the job of basic research, and industry has a vital stake in it.

The chart indicates the tiny share of research efforts in the U. S. that is devoted to basic research. Only 6% of all research by industry, and only 6% of all research in the U. S., during the year 1953

(the latest for which information is available) represented fundamental research to add to overall scientific knowledge. Even in colleges and universities less than half the research performed is basic research. At least one Nobel Prize winner has expressed the belief that we need and should work toward a doubling of the proportion of our total research effort that is devoted to basic research as soon as possible.

What Business Can Do

Without anything like a staggering increase in the total cost of its research programs, industry could do much to expand our basic research effort. Companies with big research programs should, as a matter of course, survive, be devoting a share of the effort to their own laboratories to basic research. Significantly, companies that are already doing a notable job of basic research have also made an outstanding record of translating such research into new products for industry and the consumer.

Smaller companies may rightly regard the conduct of research projects with uncertain prospects of reward as a heavy. Some basic research, indeed, never results in any tangible payoff. But, with modest contributions, small companies can still have a part in the advance of basic research. They can join together with other companies on cooperative projects. They can support basic research through trade associations and technical societies. They can help research centers in universities and other nonprofit institutions. Arrangements are available in some instances whereby business firms can pay a fee to have access to work done by university researchers.

One way or another, it is up to private business firms to see that basic research moves forward. By doing so they will be laying the groundwork for the development of the new products and technology on which their growth, and the growth of the economy, depend.

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WHERE CAN YOU USE ONE OF THESE NEW SELF-ALIGNING STOP NUTS?

Got a problem in bolting non-parallel surfaces? Still use a costly compromise like hand-selecting tapered shims? Must you resort to time-consuming, unwieldy, multiple spot-facing operations?

For a cost-saving, weight-saving, time-saving solution try the new ESNA self-aligning fasteners. To meet specific application installation problems four different designs are offered: a hex nut to standard dimensions; a double hex, high tensile fastener which develops 180,000 psi in the bolt; a floating anchor nut; and a self-wrenching type. All of these parts automatically correct for angular misalignment up to 8° in any direction from the center line.

- The self-aligning anchor nut serves as a "fixed" fastener for use where the bolt is removable but the fastener remains riveted to the structure.
- The self-aligning hex is designed for applications where a wrenchable nut can be used.
- The 12-point double hex design provides 180,000 psi high strength performance and requires a minimum of wrenching area.
- The self-wrenching design is suggested for locations where tightening with a wrench is impractical. The lug anchors itself against an adjacent surface for easy wrenching.



Each self-aligning fastener consists of a nut body with curved base and mating washer surface which act together on the ball-joint principle. Made of carbon steel for use at temperatures up to 550°F., these fasteners meet Specification AN-N-10 performance requirements and also the torque, tensile, twist-out and push-out requirements of MIL-N-25027 (ASG).

Like to know more about this line of lightweight self-aligning fasteners? Mail the coupon today.

Dept. N38-1125, Elastic Stop Nut Corporation of America
2330 Vauxhall Road, Union, New Jersey

Please send me the following free fastening information:

- ☐ Standard drawings of four new ESNA self-aligning fasteners.
☐ Here is a drawing of our product. What self-locking fastener would you suggest?

Name _____ Title _____

Firm _____

Street _____

City _____ Zone _____ State _____